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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Construction

Topic 61

Exam Focus

This topic addresses techniques for optimal portfolio construction. We will discuss important inputs into the portfolio construction process as well as ways to modify allocations by refining the position alphas within a portfolio. This topic also goes into detail regarding transactions costs and how they influence allocation decisions with regard to portfolio monitoring and rebalancing. For the exam, pay attention to the discussions of refining alpha and the implications of transactions costs. Also, be familiar with the different techniques used to construct optimal portfolios.

The Portfolio Construction Process

LO 61.1: Distinguish among the inputs to the portfolio construction process.

The process of constructing an investment portfolio has several inputs which include:

- *Current portfolio*: The assets and weights in the current portfolio. Relative to the other inputs, the current portfolio input can be measured with the most certainty.
- *Alphas*: The excess return of each asset. This input is subject to error and bias and as a result is sometimes unreasonable.
- *Covariances*: Covariance measures how the returns of the assets in the portfolio are related. Estimates of covariance often display elements of uncertainty.
- *Transactions costs*: Like covariance, transaction costs are an important input for portfolio construction, however, these costs also contain a degree of uncertainty. Transaction costs must be amortized over the investment horizon in order to determine the optimal portfolio adjustments.
- *Active risk aversion*: This input must be consistent with the specified target active risk level. Active risk is another name for tracking error, which is the standard deviation of active return (i.e., excess return).

Refining Alphas

LO 61.2: Evaluate the methods and motivation for refining alphas in the implementation process.

The motivation for refining alpha is to address the various constraints that each investor or manager might have. For the investor, constraints might include not having any short positions and/or a restriction on the amount of cash held within the portfolio. For the manager, the constraints might include restrictions on allocations to certain stocks and/or making the portfolio neutral across sectors. The resulting portfolio will be different from a corresponding unconstrained portfolio and as a result will likely be less efficient.

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Constrained optimization methods for portfolio construction are often cumbersome to implement.

A method that involves refining the alphas can derive the optimal portfolio, given the consideration of portfolio constraints, in a less complicated manner. This method refines the optimal position alphas and then adjusts each position's allocation. In other words, if no short sales are allowed, then the modified alphas would be drawn closer to zero, and the optimization that would follow would call for a zero percent allocation to those short positions. If, in addition to short sales, all long position allocations were required to more closely resemble the benchmark weights, then all modified alphas would be pulled closer to zero relative to the original alphas, indicating that the constrained portfolio would more closely resemble the benchmark portfolio (i.e., since alpha is closer to zero, the returns between the benchmark and portfolio are now closer). The main idea to this approach is that refining alphas and then optimizing position allocations can replace even the most sophisticated portfolio construction process.

A manager can refine the alphas by procedures known as scaling and trimming. By considering the structure of alpha, we can understand how to use the technique of **scaling**.

$$\text{alpha} = (\text{volatility}) \times (\text{information coefficient}) \times (\text{score})$$

In this equation, score has a mean of zero and standard deviation of one. This means that alphas will have a mean zero and a range that is determined by the volatility (i.e., residual risk) and the information coefficient (i.e., correlation between actual and forecasted outcomes). The manager can rescale the alphas to make them have the proper scale for the portfolio construction process. For example, if the original alphas had a standard deviation of 2%, the rescaled alphas could have a lower standard deviation of 0.5%.

Trimming extreme values is another method of refining alpha. The manager should scrutinize alphas that are large in absolute value terms. "Large" might be defined as three times the scale of the alphas. It may be the case that such alphas are the result of questionable data, and the weights for those position allocations should be set to zero. Those extreme alphas that appear genuine may be kept but lowered to be within some limit, say, three times the scale.

LO 61.3: Describe neutralization and methods for refining alphas to be neutral.

Neutralization is the process of removing biases and undesirable bets from alpha. There are several types of neutralization: benchmark, cash, and risk-factor. In all cases, the type of neutralization and the strategy for the process should be specified before the process begins.

Benchmark neutralization involves adjusting the benchmark alpha to zero. This means the optimal position that uses the benchmark will have a beta of one. This ensures that the alphas are benchmark-neutral and avoids any issues with benchmark timing. For example, suppose that a modified alpha has a beta of 1.2. By making this alpha benchmark-neutral, a new modified alpha will be computed where the beta is reduced to one. Making the alphas cash-neutral involves adjusting the alphas so that the cash position will not be active. It is possible to simultaneously make alphas both cash and benchmark-neutral.

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The risk-factor approach separates returns along several dimensions (e.g., industry). The manager can identify each dimension as a source of either risk or value added. The manager should neutralize the dimensions or factors that are a source of risk (for which the manager does not have adequate knowledge).

Transactions Costs

LO 61.4: Describe the implications of transaction costs on portfolio construction.

Transactions costs are the costs of moving from one portfolio allocation to another. They need to be considered in addition to the alpha and active risk inputs in the optimization process. When considering only alpha and active risk, any problem in setting the scale of the alphas can be offset by adjusting active risk aversion. The introduction of transactions costs increases the importance of the precision of the choice of scale. Some researchers propose that the accuracy of estimates of transactions costs is as important as the accuracy of alpha estimates. Furthermore, the existence of transactions costs increases the importance of having more accurate estimates of alpha.

When considering transactions costs, it is important to realize that these costs generally occur at a point in time while the benefits (i.e., the additional return) are realized over a time period. This means that the manager needs to have a rule concerning how to amortize the transactions costs over a given period. Beyond the implications of transactions costs, a full analysis would also consider the causes of transactions costs, how to measure them, and how to avoid them.

To illustrate the role of transactions costs and how to amortize them, we will assume forecasts can be made with certainty and the risk-free rate is zero. The cost of buying and selling stock is $0.05. The current prices of stock A and B are both $10. The forecasts are for the price of stock A to be $11 in one year and the price of stock B to be $12 in two years; therefore, the annualized alphas are the same at 10%. Also, neither stock will change in value after reaching the forecasted value. Now, assume in each successive year that the manager discovers a stock with the same properties as stock A and every two years a stock exactly like stock B. The manager would trade the stock-A type stocks each year and incur $0.10 in transactions costs at the end of each year. The alpha is 10%, and the transactions costs are 1% for type-A stocks for a net return of 9%. For the type-B stocks, the annual return is also 10%, but the transactions costs per year are only 0.5% because they are incurred every other year. Thus, on an annualized basis, the after-cost-return of type-B stocks is greater than that of type-A stocks.

Portfolio Construction Issues

LO 61.5: Assess the impact of practical issues in portfolio construction such as determination of risk aversion, incorporation of specific risk aversion, and proper alpha coverage.

Practical issues in portfolio construction include the level of risk aversion, the optimal risk, and the alpha coverage.

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Measuring the level of **risk aversion** is dependent on accurate measures of the inputs in the following expression:

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

For example, assuming that the information ratio is 0.8 and the desired level of active risk is 10%, then the implied level of risk aversion is 0.04. Being able to quantify risk aversion allows the manager to understand a client's utility in a mean-variance framework. Utility can be measured as: excess return – (risk aversion × variance).

Professor's Note: Remember here that active risk is just another name for tracking error. Also note that in this risk aversion equation, the desired level of active risk is inputted as a percent instead of a decimal (i.e., 10 instead of 0.10).

Aversion to specific factor risk is important for two reasons. It can help the manager address the risks associated with having a position with the potential for huge losses, and the potential dispersion across portfolios when the manager manages more than one portfolio. This approach can help a manager decide the appropriate aversion to common and specific risk factors.

Proper **alpha coverage** refers to addressing the case where the manager has forecasts of stocks that are not in the benchmark and the manager doesn't have forecasts for assets in the benchmark. When the manager has information on stocks not in the benchmark, a benchmark weight of zero should be assigned with respect to benchmarking, but active weights can be assigned to generate active alpha.

When there is not a forecast for assets in the benchmark, alphas can be inferred from the alphas of assets for which there are forecasts. One approach is to first compute the following two measures:

$$\text{value-weighted fraction of stocks with forecasts} = \text{sum of active holdings with forecasts}$$

$$\text{average alpha for the stocks with forecasts} = \frac{\text{(weighted average of the alphas with forecasts)}}{\text{(value-weighted fraction of stocks with forecasts)}}$$

The second step is to subtract this measure from each alpha for which there is a forecast and set alpha to zero for assets that do not have forecasts. This provides a set of benchmark-neutral forecasts where assets without forecasts have an alpha of zero.

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Portfolio Revisions and Rebalancing

LO 61.6: Describe portfolio revisions and rebalancing and evaluate the tradeoffs between alpha, risk, transaction costs and time horizon.

LO 61.7: Determine the optimal no-trade region for rebalancing with transaction costs.

If transactions costs are zero, a manager should revise a portfolio every time new information arrives. However, in a practical setting, the manager should make trading decisions based on expected active return, active risk, and transactions costs. The manager may wish to be conservative due to the uncertainties of these measures and the manager's ability to interpret them. Underestimating transactions costs, for example, will lead to trading too frequently. In addition, the frequent trading and short time-horizons would cause alpha estimates to exhibit a great deal of uncertainty. Therefore, the manager must choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transactions costs.

The rebalancing decision depends on the tradeoff between transactions costs and the value added from changing the position. Portfolio managers must be aware of the existence of the no-trade region where the benefits are less than the costs. The benefit of adjusting the number of shares in a portfolio of a given asset is given by the following expression:

marginal contribution to value added = (alpha of asset) – [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

As long as this value is between the negative cost of selling and the cost of purchase, the manager would not trade that particular asset. In other words, the no-trade range is as follows:

–(cost of selling) < (marginal contribution to value added) < (cost of purchase)

Rearranging this relationship with respect to alpha gives a no-trade range for alpha:

[2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] – (cost of selling) < *alpha of asset* < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

The size of the no-trade region is determined by transactions costs, risk aversion, alpha and the riskiness of the assets.

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Portfolio Construction Techniques

LO 61.8: Evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming.

The following four generic classes of procedures cover most of the applications of institutional portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. In each case the goal is the same: high alpha, low active risk, and low transactions costs. The success of a manager is determined by the value they can add minus any transaction costs:

$$\text{(portfolio alpha)} - \text{(risk aversion)} \times \text{(active risk)}^2 - \text{(transactions costs)}$$

Screens

Screens are accomplished by ranking the assets by alpha, choosing the top performing assets, and composing either an equally weighted or capitalization-based weighted portfolio. Screens can also rebalance portfolios; for example, the manager can sort the universe of portfolios by alpha; then, (1) divide the universe of assets into buy, hold, and sell decisions based on the rankings, (2) purchase any assets on the buy list not currently in the existing portfolio, and (3) sell any stocks in the portfolio that are on the sell list.

Screens are easy to implement and understand. There is a clear link between the cause (being in the buy/hold/sell class) and the effect (being a part of the portfolio). This technique is also robust in that extreme estimates of alpha will not bias the outcome. It enhances return by selecting high-alpha assets and controls risk by having a sufficient number of assets for diversification. Shortcomings of screening include ignoring information within the rankings, the fact there will be errors in the rankings, and excluding those categories of assets that tend to have low alphas (e.g., utility stocks). Also, other than having a large number of assets for diversification, this technique does not properly address risk management motives.

Stratification

Stratification builds on screens by ensuring that each category or stratum of assets is represented in the portfolio. The manager can choose to categorize the assets by economic sectors and/or by capitalization. If there are five categories and three capitalization levels (i.e., small, medium and large), then there will be 15 mutually exclusive categories. The manager would employ a screen on each category to choose assets. The manager could then weight the assets from each category based on their corresponding weights in the benchmark.

Stratification has the same benefits as screening and one fewer shortcoming in that it has solved the problem of the possible exclusion of some categories of assets. However, this technique still suffers from possible errors in measuring alphas.

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Linear Programming

Linear programming uses a type of stratification based on characteristics such as industry, size, volatility, beta, etc. without making the categories mutually exclusive. The linear programming methodology will choose the assets that produce a portfolio which closely resembles the benchmark portfolio. This technique can also include transactions costs, reduce turnover, and set position limits.

Linear programming's strength is that the objective is to create a portfolio that closely resembles the benchmark. However, the result can be very different from the benchmark with respect to the number of assets and some risk characteristics.

Quadratic Programming

Quadratic programming explicitly considers alpha, risk, and transactions costs. Like linear programming techniques, it can also incorporate constraints. Therefore, it is considered the ultimate approach in portfolio construction. This approach is only as good as its data, however, as there are many opportunities to make mistakes. Although a small mistake could lead to a large deviation from the optimal portfolio, this is not necessarily the case since small mistakes tend to cancel out in the overall portfolio.

The following loss function provides a measure that illustrates how a certain level of mistakes may only lead to a small loss, but the losses increase dramatically when the mistakes exceed a certain level:

$$\frac{\text{loss}}{\text{value added}} = \left\{1-\left[\frac{\text{actual market volatility}}{\text{estimated market volatility}}\right]^2\right\}^2$$

If actual market volatility is 20%, an underestimate of 1% will only produce a loss-to-value ratio of 0.0117. Underestimations of 2% and 3% will produce loss-to-value ratios equal to 0.055 and 0.1475, respectively. Thus, the increase in loss increases rapidly in response to given increases in error.

Portfolio Return Dispersion

LO 61.9: Describe dispersion, explain its causes and describe methods for controlling forms of dispersion.

Dispersion is a measure of how much each individual client's portfolio might be different from the composite returns reported by the manager. One measure is the difference between the maximum return and minimum return for separate account portfolios. The basic causes of dispersion are the different histories and cash flows of each of the clients.

Managers can control some forms of dispersion but unfortunately not all forms. One source of dispersion beyond the manager's control is the differing constraints that each client has (e.g., not being able to invest in derivatives or other classes of assets). Managers do, however, have the ability to control the dispersion caused by different betas since this dispersion

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often results from the lack of proper supervision. If the assets differ between portfolios, the manager can control this source of dispersion by trying to increase the proportion of assets that are common to all the portfolios.

The existence of transactions costs implies that there is some optimal level of dispersion. To illustrate the role of transactions costs in causing dispersion, we will assume a manager has only one portfolio that is invested 60% stocks and 40% bonds. The manager knows the optimal portfolio is 62% stocks and 38% bonds, but transactions costs would reduce returns more than the gains from rebalancing the portfolio. If the manager acquires a second client, he can then choose a portfolio with weights 62% and 38% for that second client. Since one client has a 60/40 portfolio and the other has a 62/38 portfolio, there will be dispersion. Clearly, higher transactions costs can lead to a higher probability of dispersion.

A higher level of risk aversion and lower transactions costs leads to lower tracking error. Without transactions costs, there will be no tracking error or dispersion because all portfolios will be optimal. The following expression shows how dispersion is proportional to active risk:

$$E(\text{max portfolio return} - \text{min portfolio return}) = 2 \times N^{-1}(0.5^{1/J}) \times (\text{active risk})$$

where:
N^{-1} = inverse of the cumulative normal distribution function N
J = number of portfolios

Adding more portfolios will tend to increase the dispersion because there is a higher chance of an extreme value with more observations. Over time, as the portfolios are managed to pursue the same moving target, convergence will occur. However, there is no certainty as to the rate this might occur.

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Key Concepts

LO 61.1

The inputs into the portfolio construction process are the current portfolio, the alphas, covariance estimates, transactions costs, and active risk aversion. With the exception of the current portfolio, all of these are subject to error and possible bias.

LO 61.2

Refining alpha is one method for including both investor constraints (e.g., no short selling) and manager constraints (e.g., proper diversification). Using refined alphas and then performing optimization can achieve the same goal as a complicated constrained optimization approach.

LO 61.3

Neutralization is the process of removing biases and undesirable bets from alphas.

Benchmark neutralization involves adjusting the benchmark alpha to zero. Cash neutralization eliminates the need for active cash management. Risk-factor neutralization neutralizes return dimensions that are only associated with risk and do not add value.

LO 61.4

Transactions costs have several implications. First, they may make it optimal not to adjust even in the face of new information. Second, transactions costs increase the importance of making alpha estimates more robust.

Including transactions costs can be complicated because they occur at one point in time, but the benefits of the portfolio adjustments are measured over the investment horizon.

LO 61.5

Practical issues in portfolio construction are the level of risk aversion, the optimal risk, and the alpha coverage. The inputs in computing the level of risk aversion need to be accurate. The aversion to a specific risk factor can help a manager address the risks of a position with a large potential loss and the dispersion across portfolios. Proper alpha coverage refers to addressing the case where the manager makes forecasts of stocks that are not in the benchmark and the manager not having forecasts for assets in the benchmark.

LO 61.6

In the process of portfolio revisions and rebalancing, there are tradeoffs between alpha, risk, transaction costs, and time horizon. The manager may wish to be conservative based on the uncertainties of the inputs. Also, the shorter the horizon, the more uncertain the alpha, which means the manager should choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transactions costs.

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LO 61.7

Because of transactions costs, there will be an optimal no-trade region when new information arrives concerning the alpha of an asset. That region would be determined by the level of risk aversion, active risk, the marginal contribution to active risk, and the transactions costs.

LO 61.8

Portfolio construction techniques include screens, stratification, linear programming, and quadratic programming. Stratification builds on screens, and quadratic programming builds on linear programming.

Screens simply choose assets based on raw alpha. Stratification first screens and then chooses stocks based on the screen and also attempts to include assets from all asset classes.

Linear programming attempts to construct a portfolio that closely resembles the benchmark by using such characteristics as industry, size, volatility, and beta. Quadratic programming builds on the linear programming methodology by explicitly considering alpha, risk, and transactions costs.

LO 61.9

For a manager with several portfolios, dispersion is the result of portfolio returns not being identical. The basic causes of dispersion are the different histories and cash flows of each of the clients. A manager can control this source of dispersion by trying to increase the proportion of assets that are common to all portfolios.

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Concept Checkers

1. The most measurable of the inputs into the portfolio construction process is the:
   A. position alphas.
   B. transactions costs.
   C. current portfolio.
   D. active risk aversion.

2. Which of the following is correct with respect to adjusting the optimal portfolio for portfolio constraints?
   A. No reliable method exists.
   B. By refining the alphas and then optimizing, it is possible to include constraints of both the investor and the manager.
   C. By refining the alphas and then optimizing, it is possible to include constraints of the investor, but not the manager.
   D. By optimizing and then refining the alphas, it is possible to include constraints of both the investor and the manager.

3. An increase in which of the following factors will increase the no-trade region for the alpha of an asset?
   I. Risk aversion.
   II. Marginal contribution to active risk.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4. Which of the following statements most correctly describes a consideration that complicates the incorporation of transactions costs into the portfolio construction process?
   A. The transactions costs and the benefits always occur in two distinct time periods.
   B. The transactions costs are uncertain while the benefits are relatively certain.
   C. There are no complicating factors from the introduction of transactions costs.
   D. The transactions costs must be amortized over the horizon of the benefit from the trade.

5. A manager has forecasts of stocks A, B, and C, but not of stocks D and E. Stocks A, B, and D are in the benchmark portfolio. Stocks C and E are not in the benchmark portfolio. Which of the following are correct concerning specific weights the manager should assign in tracking the benchmark portfolio?
   A. $w_C = 0$.
   B. $w_D = 0$.
   C. $w_C = (w_A + w_B)/2$.
   D. $w_C = w_D = w_E$.

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Concept Checker Answers

1. **C** The current portfolio is the only input that is directly observable.

2. **B** The approach of first refining alphas and then optimizing can replace even the most sophisticated portfolio construction process. With this technique both the investor and manager constraints are considered.

3. **C** This is evident from the definition of the no-trade region for the alpha of the asset.

   [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] – (cost of selling) < alpha of asset < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

4. **D** A challenge is to correctly assign the transactions costs to projected future benefits. The transactions costs must be amortized over the horizon of the benefit from the trade. The benefits (e.g., the increase in alpha) occurs over time while the transactions costs generally occur at a specific time when the portfolio is adjusted.

5. **A** The manager should assign a tracking portfolio weight equal to zero for stocks for which there is a forecast but that are not in the benchmark. A weight should be assigned to Stock D, and it should be a function of the alphas of the other assets.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Risk: Analytical Methods

Topic 62

Exam Focus

Due to diversification, the value at risk (VaR) of a portfolio will be less than or equal to the sum of the VaRs of the positions in the portfolio. If all positions are perfectly correlated, then the portfolio VaR equals the sum of the individual VaRs. A manager can make optimal adjustments to the risk of a portfolio with such measures as marginal VaR, incremental VaR, and component VaR. This topic is highly quantitative. Be able to find the optimal portfolio using the excess-return-to-marginal VaR ratios. For the exam, understand how correlations impact the measure of portfolio VaR. Also, it is important that you know how to compute incremental VaR and component VaR using the marginal VaR measure. We have included several examples to help with application of these concepts.

Portfolio theory depends a lot on statistical assumptions. In finance, researchers and analysts often assume returns are normally distributed. Such an assumption allows us to express relationships in concise expressions such as beta. Actually, beta and other convenient concepts can apply if returns follow an elliptical distribution, which is a broader class of distributions that includes the normal distribution. In what follows, we will assume returns follow an elliptical distribution unless otherwise stated.

LO 62.1: Define, calculate, and distinguish between the following portfolio VaR measures: individual VaR, incremental VaR, marginal VaR, component VaR, undiversified portfolio VaR, and diversified portfolio VaR.

Professor's Note: LO 62.1 is addressed throughout this topic.

Diversified Portfolio VaR

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:
Z_c = the z-score associated with the level of confidence c
σ_p = the standard deviation of the portfolio return
P = the nominal value invested in the portfolio

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Examining the formula for the variance of the portfolio returns is important because it reveals how the correlations of the returns of the assets in the portfolio affect volatility. The variance formula is:

$$\sigma_P^2 = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2\sum_{i=1}^{N}\sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j$$

where:
σ_P^2 = the variance of the portfolio returns
w_i = the portfolio weight invested in position *i*
σ_i = the standard deviation of the return in position *i*
$\rho_{i,j}$ = the correlation between the returns of asset *i* and asset *j*

The standard deviation, denoted σ_P, is:

$$\sigma_P = \sqrt{\sigma_P^2} = \sqrt{\sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2\sum_{i=1}^{N}\sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j}$$

Clearly, the variance and standard deviation are lower when the correlations are lower.

In order to calculate delta-normal VaR with more than one risk factor, we need a covariance matrix that incorporates correlations between each risk factor in the portfolio and volatilities of each risk factor. If we know the volatilities and correlations, we can derive the standard deviation of the portfolio and the corresponding VaR measure. We will discuss how to calculate VaR using matrix multiplication later in this topic.

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times | P_i | = Z_c \times \sigma_i \times |w_i| \times P$$

where:
P = the portfolio value
P_i = the nominal amount invested in position i

We use the absolute value of the weight because both long and short positions pose risk.

LO 62.2: Explain the role correlation has on portfolio risk.

In a two-asset portfolio, the equation for the standard deviation is:

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$$

and the VaR is:

$$VaR_P = Z_c P\sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$$

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We can square Z_c and P and put them under the square-root sign. This allows us to express VaR_P as a function of the VaRs of the individual positions, which we express as VaR_i for each position *i*. For a two-asset portfolio we will have VaR_1 and VaR_2. If the correlation is zero, $\rho_{1,2} = 0$, then the third term under the radical is zero and:

$$\text{VaR for uncorrelated positions: } VaR_P = \sqrt{VaR_1^2 + VaR_2^2}$$

The other extreme is when the correlation is one, $\rho_{1,2} = 1$. If the correlation equals one, then there is no benefit from diversification. For the two-asset portfolio, we find:

$$\text{Undiversified VaR} = VaR_P = \sqrt{VaR_1^2 + VaR_2^2 + 2VaR_1 VaR_2} = VaR_1 + VaR_2$$

In general, undiversified VaR is the sum of all the VaRs of the individual positions in the portfolio when none of those positions are short positions.

Notice how evaluating VaR using both a correlation of zero and a correlation of one will place a lower and upper bound on the total (or portfolio) VaR. Total VaR will be less if the positions are uncorrelated and greater if the positions are correlated. The following examples illustrate this point.

Example: Computing portfolio VaR (part 1)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = \$2.4 million and VaR_2 = \$1.6 million. **Compute** VaR_P if the returns of the two assets are uncorrelated.

Answer:

For uncorrelated assets:

$$VaR_P = \sqrt{VaR_1^2 + VaR_2^2} = \sqrt{(2.4^2 + 1.6^2)(\$\text{millions})^2} = \sqrt{8.32(\$\text{millions})^2}$$

$$VaR_P = \$2.8844 \text{ million}$$

Example: Computing portfolio VaR (part 2)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = \$2.4 million and VaR_2 = \$1.6 million. **Compute** VaR_P if the returns of the two assets are perfectly correlated.

Answer:

For perfectly correlated assets:

$$VaR_P = VaR_1 + VaR_2 = \$2.4 \text{ million} + \$1.6 \text{ million} = \$4 \text{ million}$$

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Under certain assumptions, the portfolio standard deviation of returns for a portfolio with more than two assets has a very concise formula. The assumptions are:

- The portfolio is equally weighted.
- All the individual positions have the same standard deviation of returns.
- The correlations between each pair of returns are the same.

The formula is then:

$$\sigma_P = \sigma\sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

where:
N = the number of positions
σ = the standard deviation that is equal for all N positions
ρ = the correlation between the returns of each pair of positions

Professor's Note: This formula greatly simplifies the process of having to calculate portfolio standard deviation with a covariance matrix.

To demonstrate the benefits of diversification, we can simply set up a 2 × 2 table where there is a small and large correlation (ρ) column and a small and large sample size (N) row. Assuming that the standard deviation of returns is 20% for both assets, we see how the portfolio variance is affected by the different inputs.

Figure 1: Portfolio Standard Deviation

Sample size/correlation	ρ = *0.1*	ρ = *0.5*
N = 4	σ_P = 11.40%	σ_P = 15.81%
N = 10	σ_P = 8.72%	σ_P = 14.83%

Example: Computing portfolio VaR (part 3)

A portfolio has five positions of $2 million each. The standard deviation of the returns is 30% for each position. The correlations between each pair of returns is 0.2. **Calculate** the VaR using a Z-value of 2.33.

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Answer:

The standard deviation of the portfolio returns is:

$$\sigma_P = 30\%\sqrt{\frac{1}{5} + \left(1 - \frac{1}{5}\right)0.2}$$

$$\sigma_P = 30\%\sqrt{0.36}$$

$$\sigma_P = 18\%$$

The VaR in nominal terms is:

$$VaR_p = Z_c \times \sigma_p \times V = (2.33)(18\%)(\$10 \text{ million})$$

$$VaR_p = \$4,194,000$$

Marginal VaR

Marginal VaR applies to a particular position in a portfolio, and it is the *per unit change in a portfolio VaR that occurs from an additional investment in that position*. Mathematically speaking, it is the partial derivative of the portfolio VaR with respect to the position:

$$\text{Marginal VaR} = MVaR_i = \frac{\partial VaR_P}{\partial(\text{monetary investment in i})} = Z_c \frac{\partial \sigma_P}{\partial w_i} = Z_c \frac{\text{cov}(R_i, R_P)}{\sigma_P}$$

Using CAPM methodology, we know a regression of the returns of a single asset *i* in a portfolio on the returns of the entire portfolio gives a beta, denoted β_i, which is a concise measure that includes the covariance of the position's returns with the total portfolio:

$$\beta_i = \frac{\text{cov}(R_i, R_P)}{\sigma_P^2}$$

Using the concept of beta gives another expression for marginal VaR:

$$\text{Marginal VaR} = MVaR_i = \frac{VaR_P}{\text{portfolio value}} \times \beta_i$$

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Example: Computing marginal VaR

Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the marginal VaR of Asset A.

Answer

$$\text{Marginal VaR}_A = (\text{VaR}_P \text{ / portfolio value}) \times \beta_A$$

$$\text{Marginal VaR}_A = (400{,}000 \text{ / } 4{,}000{,}000) \times 1.2 = 0.12$$

Thus, portfolio VaR will change by 0.12 for each euro change in Asset A.

Incremental VaR

LO 62.3: Describe the challenges associated with VaR measurement as portfolio size increases.

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. Since it applies to an entire position, it is generally larger than marginal VaR and may include nonlinear relationships, which marginal VaR generally assumes away. The problem with measuring incremental VaR is that, in order to be accurate, a full revaluation of the portfolio after the addition of the new position would be necessary. The incremental VaR is the difference between the new VaR from the revaluation minus the VaR before the addition. The revaluation requires not only measuring the risk of the position itself, but it also requires measuring the change in the risk of the other positions that are already in the portfolio. For a portfolio with hundreds or thousands of positions, this would be time consuming. Clearly, VaR measurement becomes more difficult as portfolio size increases given the expansion of the covariance matrix. Using a shortcut approach for computing incremental VaR would be beneficial.

For small additions to a portfolio, we can approximate the incremental VaR with the following steps:

Step 1: Estimate the risk factors of the new position and include them in a vector [η].
Step 2: For the portfolio, estimate the vector of marginal VaRs for the risk factors [$MVaR_j$].
Step 3: Take the cross product.

This probably requires less work and is faster to implement because it is likely the managers already have estimates of the vector of $MVaR_j$ values in Step 2.

Before we take a look at how to calculate incremental VaR, let's review the calculation of delta-normal VaR using matrix notation (i.e., using a covariance matrix).

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Example: Computing VaR using matrix notation

A portfolio consists of assets A and B. These assets are the risk factors in the portfolio. The volatilities are 6% and 14%, respectively. There are \$4 million and \$2 million invested in them, respectively. If we assume they are uncorrelated with each other, **compute** the VaR of the portfolio using a confidence parameter, Z, of 1.65.

Answer:

We can use matrix notation to derive the dollar variance of the portfolio:

$$\sigma_p{}^2V^2 = [\$4\ \$2]\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4\\ \$2\end{bmatrix} = 0.0576 + 0.0784 = 0.136$$

This value is in (\$ millions)^2. VaR is then the square root of the portfolio variance times 1.65:

$$\text{VaR} = (1.65)(\$368{,}782) = \$608{,}490$$

Professor's Note: Matrix multiplication consists of multiplying each row by each column. For example: $(4 \times 0.06^2) + (2 \times 0) = 0.0144$; $0.0144 \times 4 = 0.0576$. Had the positions been positively correlated, some positive value would replace the zeros in the covariance matrix.

Example: Computing incremental VaR

A portfolio consists of assets A and B. The volatilities are 6% and 14%, respectively. There are \$4 million and \$2 million invested in them respectively. If we assume they are uncorrelated with each other, **compute** the incremental VaR for an increase of \$10,000 in Asset A. Assume a Z-score of 1.65.

Answer:

To find incremental VaR, we compute the per dollar covariances of each risk factor:

$$\begin{bmatrix}\text{cov}(R_A, R_P)\\ \text{cov}(R_B, R_P)\end{bmatrix} = \begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$4\\ \$2\end{bmatrix} = \begin{bmatrix}0.0144\\ 0.0392\end{bmatrix}$$

These per dollar covariances represent the covariance of a given risk factor with the portfolio. Thus, we can substitute these values into the marginal VaR equations for the risk factors as follows.

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The marginal VaRs of the two risk factors are:

$$MVaR_A = Z_c \times \frac{cov(R_A, R_P)}{\sigma_P} = 1.65 \times \frac{0.0144}{\sqrt{0.136}} = 0.064428$$

$$MVaR_B = Z_c \times \frac{cov(R_B, R_P)}{\sigma_P} = 1.65 \times \frac{0.0392}{\sqrt{0.136}} = 0.175388$$

Since the two assets are uncorrelated, the incremental VaR of an additional $10,000 investment in Position A would simply be $10,000 times 0.064428, or $644.28.

Component VaR

Component VaR for position *i*, denoted $CVaR_i$, is the amount of risk a particular fund contributes to a portfolio of funds. It will generally be less than the VaR of the fund by itself (i.e., stand alone VaR) because of diversification benefits at the portfolio level. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$$

Using $CVaR_i$, we can express the total VaR of the portfolio as:

$$VaR = \sum_{i=1}^{N} CVaR_i = VaR\left(\sum_{i=1}^{N} w_i \times \beta_i\right)$$

Given the way the betas were computed we know:

$$\left(\sum_{i=1}^{N} w_i \times \beta_i\right) = 1$$

Example: Computing component VaR (Example 1)

Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the component VaR of Asset A.

Answer:

$$\text{Component } VaR_A = VaR_P \times \beta_A \times \text{asset weight}$$

$$\text{Component } VaR_A = 400{,}000 \times 1.2 \times (1{,}000{,}000 / 4{,}000{,}000) = €120{,}000$$

Thus, portfolio VaR will decrease by €120,000 if Asset A is removed.

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Example: Computing component VaR (Example 2, Part 1)

Recall our previous incremental VaR example of a portfolio invested \$4 million in A and \$2 million in B. Using their respective marginal VaRs, 0.064428 and 0.175388, **compute** the component VaRs.

Answer:

$$CVaR_A = (MVaR_A) \times (w_A \times P) = (0.064428) \times (\$4 \text{ million}) = \$257{,}713$$

$$CVaR_B = (MVaR_B) \times (w_B \times P) = (0.175388) \times (\$2 \text{ million}) = \$350{,}777$$

Professor's Note: The values have been adjusted for rounding.

Example: Computing component VaR (Example 2, Part 2)

Using the results from the previous example, **compute** the percent of contribution to VaR of each component.

Answer:

The answer is the sum of the component VaRs divided into each individual component VaR:

$$\% \text{ contribution to VaR from A} = \frac{\$257{,}713}{(\$257{,}713 + \$350{,}777)} = 42.35\%$$

$$\% \text{ contribution to VaR from B} = \frac{\$350{,}777}{(\$257{,}713 + \$350{,}777)} = 57.65\%$$

Normal distributions are a subset of the class of distributions called elliptical distributions. As a class, elliptical distributions have fewer assumptions than normal distributions. Risk management often assumes elliptical distributions, and the procedures to estimate component VaRs up to this point have applied to elliptical distributions.

If the returns do not follow an elliptical distribution, we can employ other procedures to compute component VaR. If the distribution is homogeneous of degree one, for example, then we can use Euler's theorem to estimate the component VaRs. The return of a portfolio of assets is homogeneous of degree one because, for some constant, *k*, we can write:

$$k \times R_P = \sum_{i=1}^{N} k \times w_i \times R_i$$

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The following steps can help us find component VaRs for a non-elliptical distribution using historical returns:

Step 1: Sort the historical returns of the portfolio.
Step 2: Find the return of the portfolio, which we will designate $R_{P(VaR)}$, that corresponds to a return that would be associated with the chosen VaR.
Step 3: Find the returns of the individual positions that occurred when $R_{P(VaR)}$ occurred.
Step 4: Use each of the position returns associated with $R_{P(VaR)}$ for component VaR for that position.

To improve the estimates of the component VaRs, an analyst should probably obtain returns for each individual position for returns of the portfolio slightly above and below $R_{P(VaR)}$. For each set of returns for each position, the analyst would compute an average to better approximate the component VaR of the position.

Managing Portfolios Using VaR

LO 62.4: Apply the concept of marginal VaR to guide decisions about portfolio VaR.

A manager can *lower a portfolio VaR by lowering allocations to the positions with the highest marginal VaR*. If the manager keeps the total invested capital constant, this would mean increasing allocations to positions with lower marginal VaR. Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all *i* and *j*:

$$MVaR_i = MVaR_j$$

We can use our earlier example to see how we can use marginal VaRs to make decisions to lower the risk of the entire portfolio. In the earlier example, Position A has the smaller MVaR; therefore, we will compute the marginal VaRs and total VaR for a portfolio which has \$5 million invested in A and \$1 million in B. The portfolio variance is:

$$\sigma_P^2 V^2 = [\$5\ \$1]\begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$5\\ \$1\end{bmatrix} = 0.0900 + 0.0196 = 0.1096$$

This value is in (\$ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

$$VaR = (1.65)(\$331{,}059) = \$546{,}247$$

The VaR of \$546,247 is less than the VaR of \$608,490, which was produced when Portfolio A had a lower weight. We can see that the marginal VaRs are now much closer in value:

$$\begin{bmatrix}cov(R_A,R_P)\\ cov(R_B,R_P)\end{bmatrix} = \begin{bmatrix}0.06^2 & 0\\ 0 & 0.14^2\end{bmatrix}\begin{bmatrix}\$5\\ \$1\end{bmatrix} = \begin{bmatrix}0.0180\\ 0.0196\end{bmatrix}$$

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The marginal VaRs of the two positions are:

$$MVaR_A = Z_c \times \frac{cov(R_A, R_P)}{\sigma_P} = 1.65 \times \frac{0.0180}{\sqrt{0.1096}} = 0.08971$$

$$MVaR_B = Z_c \times \frac{cov(R_B, R_P)}{\sigma_P} = 1.65 \times \frac{0.0196}{\sqrt{0.1096}} = 0.09769$$

LO 62.5: Explain the difference between risk management and portfolio management, and describe how to use marginal VaR in portfolio management.

As the name implies, risk management focuses on risk and ways to reduce risk; however, minimizing risk may not produce the optimal portfolio. Portfolio management requires assessing both risk measures and return measures to choose the optimal portfolio. Traditional efficient frontier analysis tells us that the minimum variance portfolio is not optimal. We should note that the **efficient frontier** is the plot of portfolios that have the lowest standard deviation for each expected return (or highest return for each standard deviation) when plotted on a plane with the vertical axis measuring return and the horizontal axis measuring the standard deviation. The optimal portfolio is represented by the point where a ray from the risk-free rate is just tangent to the efficient frontier. That optimal portfolio has the highest Sharpe ratio:

$$\text{Sharpe ratio} = \frac{\text{(portfolio return} - \text{risk-free rate)}}{\text{(standard deviation of portfolio return)}}$$

We can modify this formula by replacing the standard deviation with VaR so that the focus then becomes the excess return of the portfolio over VaR:

$$\frac{\text{(portfolio return} - \text{risk-free rate)}}{\text{(VaR of portfolio)}}$$

This ratio is maximized when the excess return in each position divided by its respective marginal VaR equals a constant. In other words, at the optimum:

$$\frac{\text{(Position i return} - \text{risk-free rate)}}{(MVaR_i)} = \frac{\text{(Position j return} - \text{risk-free rate)}}{(MVaR_j)}$$

for all positions *i* and *j*

Professor's Note: Equating the excess return/MVaR ratios will obtain the optimal portfolio. This differs from equating just the MVaRs, as in the last LO, which obtains the portfolio with the lowest portfolio VaR.

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Assuming that the returns follow elliptical distributions, we can represent the condition in a more concise fashion by employing betas, β_i, which are obtained from regressing each position's return on the portfolio return:

$$\frac{\text{(Position i return} - \text{risk-free rate)}}{\beta_i} = \frac{\text{(Position j return} - \text{risk-free rate)}}{\beta_j}$$

for all positions *i* and *j*

The portfolio weights that make these ratios equal will be the optimal portfolio. We now turn our attention to determining the optimal portfolio for our example portfolio of A and B. We will assume the expected excess return of A is 6% and that of B is 11%. Even without this information, we should know that the optimal portfolio will have an allocation in A less than \$5 million and in B greater than \$1 million. This is because the marginal VaRs were almost equal with those allocations. *Thus, the resulting portfolio would be close to the minimum variance,* which will not be optimal. We might want to find out how to adjust the allocation with respect to the original values of \$4 million in A and \$2 million in B. By comparing the ratios of the two assets we find:

$$\frac{\text{Excess return of A}}{\text{MVaR}_A} = \frac{0.06}{0.064428} = 0.9313$$

$$\frac{\text{Excess return of B}}{\text{MVaR}_B} = \frac{0.11}{0.175388} = 0.6272$$

We see that there is too much allocated in B. Before we adjust the portfolio, we compute the excess-return-to-VaR ratio for the entire portfolio. The return is:

$$\text{\% excess return on portfolio} = 7.67\% = \frac{\$4 \text{ million}}{\$6 \text{ million}}(6\%) + \frac{\$2 \text{ million}}{\$6 \text{ million}}(11\%)$$

The return to VaR (scaled by the size of the portfolio) is:

$$0.7559 = \frac{0.0767}{\$608{,}490} \times \$6 \text{ million}$$

Now, because the return to MVaR ratio was greater for A, we will increase the allocation in A to \$4.5 million and decrease that in B to \$1.5 million. With those changes, the portfolio variance is:

$$\sigma_p{}^2 V^2 = [\$4.5\ \$1.5]\begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix}\begin{bmatrix} \$4.5 \\ \$1.5 \end{bmatrix} = 0.0729 + 0.0441 = 0.1170$$

This value is in (\$ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

VaR = (1.65)(\$342,053) = \$564,387

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In this case, the marginal VaRs are found by:

$$\begin{bmatrix} \text{cov}(R_A, R_P) \\ \text{cov}(R_B, R_P) \end{bmatrix} = \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$4.5 \\ \$1.5 \end{bmatrix} = \begin{bmatrix} 0.0162 \\ 0.0294 \end{bmatrix}$$

The marginal VaRs of the two positions are then:

$$\text{MVaR}_A = Z_c \times \frac{\text{cov}(R_A, R_P)}{\sigma_P} = 1.65 \times \frac{0.0162}{\sqrt{0.1170}} = 0.0781$$

$$\text{MVaR}_B = Z_c \times \frac{\text{cov}(R_B, R_P)}{\sigma_P} = 1.65 \times \frac{0.0294}{\sqrt{0.1170}} = 0.1418$$

We see the expected excess-return-to-marginal VaR ratios are much closer:

$$\frac{0.06}{0.0781} = 0.7678$$

$$\frac{0.11}{0.1418} = 0.7756$$

The portfolio return is now:

$$\%\text{ excess return on portfolio} = 7.25\% = \frac{\$4.5\text{ million}}{\$6\text{ million}}(6\%) + \frac{\$1.5\text{ million}}{\$6\text{ million}}(11\%)$$

The portfolio return divided by the portfolio VaR has risen. The return to VaR (scaled by the size of the portfolio) is:

$$0.7707 = \frac{0.0725}{\$564{,}387} \times \$6\text{ million}$$

This is greater than the 0.7559 value associated with the original \$4 million and \$2 million allocations. The result is a more optimal portfolio allocation.

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Key Concepts

LO 62.1

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects.

Individual VaR is the VaR of an individual position in isolation.

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:
Z_c = the *z*-score associated with the level of confidence *c*
σ_p = the standard deviation of the portfolio return
P = the nominal value invested in the portfolio

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$$

where:
P = the portfolio value
P_i = the nominal amount invested in position i

Marginal VaR is the change in a portfolio VaR that occurs from an additional one unit investment in a given position. Useful representations are:

$$\text{Marginal VaR} = MVaR_i = Z_c \frac{\text{cov}(R_i, R_P)}{\sigma_P}$$

$$\text{Marginal VaR} = MVaR_i = \frac{VaR}{P} \times \beta_i$$

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. It can be calculated precisely from a total revaluation of the portfolio, but this can be costly. A less costly approximation is found by (1) breaking down the new position into risk factors, (2) multiplying each new risk factor times the corresponding partial derivative of the portfolio with respect to the risk factor, and then (3) adding up all the values.

Component VaR for position *i*, denoted $CVaR_i$, is the amount a portfolio VaR would change from deleting that position in a portfolio. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$$

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There is a method for computing component VaRs for distributions that are not elliptical. The procedure is to sort the historical returns of the portfolio and designate a portfolio return that corresponds to the loss associated with the VaR and then find the returns of each of the components associated with that portfolio loss. Those position returns can be used to compute component VaRs.

LO 62.2

For a two-asset portfolio, two special cases are:

1. VaR for uncorrelated positions:
   $$\text{VaR}_P = \sqrt{\text{VaR}_1{}^2 + \text{VaR}_2{}^2}$$
2. VaR for perfectly correlated positions:
   $$\text{Undiversified VaR} = \text{VaR}_P = \sqrt{\text{VaR}_1{}^2 + \text{VaR}_2{}^2 + 2\text{VaR}_1\text{VaR}_2} = \text{VaR}_1 + \text{VaR}_2$$

LO 62.3

The incremental VaR is the difference between the new VaR from the revaluation minus the VaR before the addition. The revaluation requires not only measuring the risk of the position itself, but it also requires measuring the change in the risk of the other positions that are already in the portfolio. For a portfolio with hundreds or thousands of positions, this would be time consuming.

LO 62.4

Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all *i* and *j*:

$$\text{MVaR}_i = \text{MVaR}_j$$

LO 62.5

The optimal portfolio is the one for which all excess-return-to-marginal VaR ratios are equal:

$$\frac{(\text{Position i return} - \text{risk-free rate})}{(\text{MVaR}_i)} = \frac{(\text{Position j return} - \text{risk-free rate})}{(\text{MVaR}_j)}$$

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Concept Checkers

1. Which of the following is the best synonym for diversified VaR?
   A. Vector VaR.
   B. Position VaR.
   C. Portfolio VaR.
   D. Incidental VaR.

2. When computing individual VaR, it is proper to:
   A. use the absolute value of the portfolio weight.
   B. use only positive weights.
   C. use only negative weights.
   D. compute VaR for each asset within the portfolio.

3. A portfolio consists of two positions. The VaR of the two positions are \$10 million and \$20 million. If the returns of the two positions are not correlated, the VaR of the portfolio would be closest to:
   A. \$5.48 million.
   B. \$15.00 million
   C. \$22.36 million.
   D. \$25.00 million.

4. Which of the following is true with respect to computing incremental VaR? Compared to using marginal VaRs, computing with full revaluation is:
   A. more costly, but less accurate.
   B. less costly, but more accurate.
   C. less costly, but also less accurate.
   D. more costly, but also more accurate.

5. A portfolio has an equal amount invested in two positions, X and Y. The expected excess return of X is 9% and that of Y is 12%. Their marginal VaRs are 0.06 and 0.075, respectively. To move toward the optimal portfolio, the manager will probably:
   A. increase the allocation in Y and/or lower that in X.
   B. increase the allocation in X and/or lower that in Y.
   C. do nothing because the information is insufficient.
   D. not change the portfolio because it is already optimal.

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Concept Checker Answers

1. **C** Portfolio VaR should include the effects of diversification. None of the other answers are types of VaRs.

2. **A** The expression for individual VaR is $VaR_i = Z_c \times \sigma \times | P_i | = Z \times \sigma_i \times |w_i| \times P$. The absolute value signs indicate that we need to measure the risk of both positive and negative positions, and risk cannot be negative.

3. **C** For uncorrelated positions, the answer is the square root of the sum of the squared VaRs:

$$VaR_P = \sqrt{(10^2 + 20^2)} \times (\$ \text{ million}) = \$22.36 \text{ million.}$$

4. **D** Full revaluation means recalculating the VaR of the entire portfolio. The marginal VaRs are probably already known, so using them is probably less costly, but will not be as accurate.

5. **A** The expected excess-return-to-MVaR ratios for X and Y are 1.5 and 1.6, respectively. Therefore, the portfolio weight in Y should increase to move the portfolio toward the optimal portfolio.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

VaR and Risk Budgeting in Investment Management

Topic 63

Exam Focus

Banks on the "sell side" of the investment industry have long used risk budgeting and value at risk (VaR). There is a trend for the "buy side" investment firms to increasingly use VaR. One reason for increased demand for risk budgeting is the increased complexity, dynamics, and globalization of the investment industry. Use of VaR can help set better guidelines than more traditional limits. By measuring marginal and incremental VaRs, a manager can make better decisions concerning portfolio weights. For the exam, be comfortable with the concept of surplus at risk (SaR). Also, understand how to budget risk across asset classes and active managers.

Risk Budgeting

LO 63.1: Define risk budgeting.

Risk budgeting is a top-down process that involves choosing and managing exposures to risk. The main idea is that the risk manager establishes a risk budget for the entire portfolio and then allocates risk to individual positions based on a predetermined fund risk level. The risk budgeting process differs from market value allocation since it involves the allocation of risk.

Managing Risk With VaR

LO 63.2: Describe the impact of horizon, turnover and leverage on the risk management process in the investment management industry.

The "sell side" of the investment industry largely consists of banks that have developed VaR techniques and have used them for many years. Investors make up the "buy side" of the investment industry. Investors are now using VaR techniques, but they have to adapt them to the different nature of that side of the business. To understand why the needs are different, we should compare the characteristics of the two "sides." Figure 1 makes direct comparisons.

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Figure 1: Sell Side and Buy Side Characteristics

Characteristic	*Sell Side*	*Buy Side*
Horizon	Short-term (days)	Long-term (month or more)
Turnover	Fast	Slow
Leverage	High	Low
Risk measures	VaR Stress tests	Asset allocation Tracking error
Risk controls	Position limits VaR limits Stop-loss rules	Diversification Benchmarking Investment guidelines

Banks trade rapidly, which is why they cannot rely on traditional measures of risk that are based on historical data. For banks, yesterday's risk may not have anything to do with today's positions. Investors usually try to hold positions for longer periods of time (e.g., years).

Having a more dynamic method for measuring risk such as VaR is also important for banks because of their high leverage. Institutional investors often have much stronger constraints with respect to leverage; therefore, they have a much lower need to control downside risk.

The Investment Process

LO 63.3: Describe the investment process of large investors such as pension funds.

The *first step* in the investment process is to determine the long-term, strategic asset allocations. Usually, the goal of the first step is to balance returns and risks using methods like mean-variance portfolio optimization. This step determines the allocations to asset classes such as domestic and foreign stocks, domestic and foreign bonds, and alternative investments such as real estate, venture capital, and hedge funds. Making this allocation relies on passive indices and other benchmarks to help measure the properties of the investment, and the availability of passive indices helps make the allocations feasible.

The *second step* in the investment process is to choose the managers who may either passively manage the fund (i.e., simply track the benchmarks) or actively manage the fund in an effort to outperform the benchmarks. The investors should review the managers' activities and performance periodically. Their activities should conform to a list of guidelines, which includes the types of investments and risk exposure restrictions such as beta and duration. Managers' performance can be evaluated by analyzing their tracking error.

VaR risk management systems are beginning to become more important because of the globalization of available investments and the increased complexity of investments. Also, investment companies are becoming more dynamic, which makes it more difficult to assess risk. With many managers, for example, each of the managers may make changes within his/her constraints, but the collective changes could be difficult to gauge with historical measures. In sum, because of increased globalization, complexity, and the dynamic nature of the investment industry, simply measuring risk using historical measures is no longer adequate, which has increased the need for VaR.

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Hedge Fund Issues

LO 63.4: Describe the risk management challenges associated with investments in hedge funds.

Hedge funds are a very heterogeneous class of assets that include a variety of trading strategies. Since they often use leverage and trade a great deal, their risk characteristics may be more similar to the "sell side" of the industry. Hedge funds have some other risks like liquidity and low transparency. Liquidity risk has many facets. First, there is the obvious potential loss from having to liquidate too quickly. Second, there is the difficulty of measuring the exact value of the fund to be able to ascertain its risk. Furthermore, the low liquidity tends to lower the volatility of historical prices as well as the correlations of the positions. These properties will lead to an underestimation of traditional measures of risk. In addition to these risks, there is the low level of transparency. This makes the risk measurement difficult with respect to both the size and type. Not knowing the type of risk increases the difficulty of risk management for the entire portfolio in which an investor might include hedge funds.

Absolute vs. Relative Risk and Policy Mix vs. Active Risk

LO 63.5: Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk and sponsor risk.

Absolute or asset risk refers to the total possible losses over a horizon. It is simply measured by the return over the horizon. **Relative risk** is measured by excess return, which is the dollar loss relative to a benchmark. The shortfall is measured as the difference between the fund return and that of a benchmark in dollar terms. VaR techniques can apply to tracking error (i.e., standard deviation of excess return) if the excess return is normally distributed.

Professor's Note: The author's definition of tracking error differs from the definition of tracking error in other assigned readings. Jorion defines tracking error as active return minus the benchmark return. In other readings, this value is simply the excess return and tracking error is the volatility (i.e., standard deviation) of the excess return. Throughout this topic, we have expressed excess return as portfolio return minus benchmark return and tracking error as the volatility of the excess return. This methodology follows the definition of tracking error on previous FRM exams.

Distinguishing **policy mix** from **active risk** is important when an investment firm allocates funds to different managers in various asset classes. This breaks down the risk of the total portfolio into that associated with the target policy (i.e., the weights assigned to the various funds in the policy) and the risk from the fact that managers may make decisions which lead to deviations from the designated weights. VaR analysis is especially useful here because it can show the risk exposure associated with the two types of risk and how they affect the overall risk of the entire portfolio. Often, active management risk is not much of a problem for several reasons:

- For well-managed funds, it is usually fairly small for each of the individual funds.

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- There will be diversification effects across the deviations.
- There can be diversification effects with the policy mix VaR to actually lower the total portfolio VaR.

Funding Risk

Funding risk refers to being able to meet the obligations of an investment company (e.g., a pension's payout to retirees). Put another way, funding risk is the risk that the value of assets will not be sufficient to cover the liabilities of the fund. The level of funding risk varies dramatically across different types of investment companies. Some have zero, while defined benefit pension plans have the highest.

The focus of this analysis is the surplus, which is the difference between the value of the assets and the liabilities, and the change in the surplus, which is the difference between the change in the assets and liabilities:

Surplus = Assets – Liabilities

ΔSurplus = ΔAssets – ΔLiabilities

Typically, in managing funding risk, an analyst will transform the nominal return on the surplus into a return on the assets, and break down the return as indicated:

$$R_{surplus} = \frac{\Delta Surplus}{Assets} = \frac{\Delta Assets}{Assets} - \left(\frac{\Delta Liabilities}{Liabilities}\right)\left(\frac{Liabilities}{Assets}\right) = R_{asset} - R_{liabilities}\left(\frac{Liabilities}{Assets}\right)$$

Evaluating this expression requires assumptions about the liabilities, which are in the future and uncertain. For pension funds, liabilities represent "accumulated benefit obligations," which are the present value of pension benefits owed to the employees and other beneficiaries. Determining the present value requires a discount rate, which is usually tied to some current level of interest rates in the market. An ironic aspect of funding risk is that assets for meeting the obligations like equities and bonds usually increase in value when interest rates decline, but the present value of future obligations may increase even more. When assets and liabilities change by different amounts, this affects the surplus, and the resulting volatility of the surplus is a source of risk. If the surplus turns negative, additional contributions will be required. This is called **surplus at risk** (SaR).

One answer to this problem is to immunize the portfolio by making the duration of the assets equal that of the liabilities. This may not be possible since the necessary investments may not be available, and it may not be desirable because it may mean choosing assets with a lower return.

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Example: Determining a fund's risk profile

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected return on the surplus, scaled by assets, is 4%. This means the surplus is expected to grow by $8 million over the first year. The volatility of the surplus is 10%. Using a Z-score of 1.65, **compute** VaR and the associated deficit that would occur with the loss associated with the VaR.

Answer:

First, we calculate the expected value of the surplus. The current surplus is $20 million (= $200M – $180M). It is expected to grow another $8 million to a value of $28 million. As for the VaR:

VaR = (1.65)(10%)($200 million) = $33 million

If this decline in value occurs, the deficit would be the difference between the VaR and the expected surplus value: $33 million – $28 million = $5 million.

Professor's Note: According to the assigned reading, the surplus at risk (SaR) is the VaR amount calculated above. Note that SaR on previous exams has been approached differently, as illustrated in the following example. Be prepared for either approach on the actual exam. In the example to follow, we will illustrate how to calculate the volatility of surplus growth. On previous FRM exams, this value has not been provided.

Example: Surplus at risk (via computing volatility of surplus)

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected annual return on the assets is 4% and the expected annual growth of the liabilities is 3%. Also assume that the volatility of the asset return is 10% and the volatility of the liability growth is 7%. **Compute** 95% surplus at risk assuming the correlation between asset return and liability growth is 0.4.

Answer:

First, compute the expected surplus growth:

200 × (0.04) – 180 × (0.03) = $2.6 million

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Next, compute the volatility of the surplus growth. To compute the volatility you need to recall one of the properties of covariance discussed in the FRM Part I curriculum. The variance of assets minus liabilities [i.e., Var(A-L)] = Var(A) + Var(L) – 2 × Cov(A,L). Where covariance is equal to the standard deviation of assets times the standard deviation of liabilities times the correlation between the two. The asset and liability amounts will also need to be applied to this formula.

$$\text{Variance(A-L)} = 200^2 \times 0.10^2 + 180^2 \times 0.07^2 - 2 \times 200 \times 180 \times 0.10 \times 0.07 \times 0.4$$

$$= 400 + 158.76 - 201.6 = \$357.16 \text{ million}$$

$$\text{Standard deviation} = \sqrt{357.16} = \$18.89$$

Thus, SaR can be calculated by incorporating the expected surplus growth and standard deviation of the growth.

$$95\% \text{ SaR} = 2.6 - 1.65 \times 18.89 = \$28.57 \text{ million}$$

Professor's Note: Like VaR, SaR is a negative value since it is the surplus amount that is at risk. As a result, the negative sign is usually not presented since a negative amount is implied.

Plan Sponsor Risk

The plan sponsor risk is an extension of surplus risk and how it relates to those who ultimately bear responsibility for the pension fund. We can distinguish between the following risk measures:

- **Economic risk** is the variation in the total economic earnings of the plan sponsor. This takes into account how the risks of the various components relate to each other (e.g., the correlation between the surplus and operating profits).
- **Cash-flow risk** is the variation of contributions to the fund. Being able to absorb fluctuations in cash flow allows for a more volatile risk profile.

Ultimately, from the viewpoint of the sponsor, the focus should be on the variation of the economic value of the firm. The management should integrate the various risks associated with the movement of the assets and surplus with the overall financial goals of the sponsor. This is aligned with the current emphasis on enterprise-wide risk management.

Monitoring Risk With VaR

LO 63.6: Apply VaR to check compliance, monitor risk budgets and reverse engineer sources of risk.

There are many types of risks that can increase dramatically in a large firm. For example, the "rogue trader" phenomenon is more likely in a large firm. This occurs when a manager of one of the accounts or funds within the larger portfolio deviates from his/her guidelines

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in terms of portfolio weights or even trades in unauthorized investments. Such deviations from compliance can be very short-term, and regular reporting measures may not catch the violations.

Risk management is necessary for all types of portfolios—even passively managed portfolios. Some analysts erroneously believe that passive investing, or benchmarking, does not require risk monitoring. This is not true because the risk profiles of the benchmarks change over time. In the late 1990s, a portfolio benchmarked to the S&P 500 would clearly have seen a change in risk exposures (e.g., an increase in the exposure to risks associated with the high-tech industry). A forward-looking risk measurement system would pick up on such trends.

Monitoring the risk of actively managed portfolios should help identify the reasons for changes in risk. Three explanations for dramatic changes in risk are (1) a manager taking on more risk, (2) different managers taking similar bets, and (3) more volatile markets. Thus, when there is an increase in the overall risk of a portfolio, top management would want to investigate the increase by asking the following questions.

Has the manager exceeded his/her risk budget? VaR procedures and risk management can allocate a risk budget to each manager. The procedures should give an indication if and why the manager exceeds the risk budget. Is it a temporary change from changes in the market? Has the manager unintentionally let the weights of the portfolio drift so as to increase risk? Or, more seriously, has the manager engaged in unauthorized trades?

Are managers taking too many of the same style bets? If the managers are acting independently, it is possible that they all start pursuing strategies with the same risk exposures. This could happen, for example, if all managers forecast lower interest rates. Bond managers would probably begin moving into long-term bonds, and equity managers would probably begin moving into stocks that pay a high and stable dividend like utility companies and REITs. This would drastically increase the interest rate risk of the overall portfolio.

Have markets become more volatile? If the risk characteristics of the entire market have changed, top management will have to decide if it is worth accepting the volatility or make decisions to reduce it by changing the target portfolio weights.

VaR can also be reverse engineered by utilizing the VaR tools outlined in the previous topic, such as component VaR and marginal VaR. These tools provide insight on how the overall portfolio will be affected by individual position changes. This method can be used provided that all relevant risks have been identified within the risk management system.

In the risk management process, there is a problem with measuring the risk of some unique asset classes like real estate, hedge funds, and venture capital. Also, there may be limited information on investments in a certain class (e.g., emerging markets and initial public offerings).

There is a trend in the investment industry toward management choosing a **global custodian** for the firm. Such a choice means an investor aggregates the portfolios with a single custodian, which more easily allows a consolidated picture of the total exposures of the fund. The custodian can combine reports on changes in positions with market data to produce forward-looking risk measures. Thus, the global custodian is an easy choice in pursuing centralized risk management. Along with the trend toward global custodians,

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there has been a trend in the "custodian industry" toward fewer custodians that can provide more services. Large custodian banks such as Citibank, Deutsche Bank, and State Street are providing risk management products.

Those that choose not to use a global custodian have done so because they feel that they have a tighter control over risk measures and can better incorporate VaR systems into operations. There are often economies of scale for larger firms in that they can spread the cost of risk management systems over a large asset base. Also, they can require tighter control when their assets are partly managed internally.

Increasingly, clients are asking money managers about their risk management systems. The clients are no longer satisfied with quarterly performance reports. Many investment managers have already incorporated VaR systems into their investment management process. Widely used risk standards for institutional investors recommend measuring the risk of the overall portfolio and measuring the risk of each instrument. It may be the case that those who do not have comprehensive risk management systems will soon be at a significant disadvantage to those who do have such systems. There also seems to be some attempt by managers to differentiate themselves with respect to risk management.

VaR Applications

LO 63.7: Explain how VaR can be used in the investment process and the development of investment guidelines.

Investment Guidelines

VaR can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Clearly, ad hoc procedures will generally be inferior to formal guidelines using established principles. Also, limits on notionals and sensitivities have proven insufficient when leverage and positions in derivatives exist. The limits do not account for variations in risk nor correlations. VaR limits include all of these factors.

The problem with controlling positions and not risk is that there are many rules and restrictions, which in the end may not achieve the main goal. There is no measure of the possible losses that can occur in a given time period—a good quantity to identify in order to know how much capital to have on hand to meet liquidity needs. Furthermore, simple restrictions on certain positions can be easily evaded with the many instruments that are now available. As a wider range of products develop, obviously, the traditional and cumbersome position-by-position guidelines will become even less effective.

Investment Process

VaR can help in the first step of the investment process, which is the strategic asset-allocation decision. Since this step usually uses mean-variance analysis, as does the most basic VaR measures, VaR can help in the portfolio allocation process. Furthermore, VaR can

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measure specific changes in risk that can result as managers subjectively adjust the weights from those recommended by pure quantitative analysis.

VaR is also useful at the trading level. A trader usually focuses on the return and stand-alone risk of a proposed position. The trader may have some idea of how the risk of the position will affect the overall portfolio, but an adequate risk management system that uses VaR can give a specific estimate of the change in risk. In fact, the risk management system should stand ready to automatically calculate the marginal VaR of each existing position and proposed position. When the trader has the choice between adding one of two positions with similar return characteristics, the trader would choose the one with the lower marginal VaR. VaR methodology can help make choices between different assets too. The optimal portfolio will be the one that has the excess-return-to-marginal VaR ratios equal for all asset types, as seen in the previous topic. Thus, when a trader is searching for the next best investment, the trader will look at securities in the asset classes that currently have the higher returns-to-marginal-VaR ratios.

Budgeting Risk

LO 63.8: Describe the risk budgeting process across asset classes and active managers.

Risk budgeting should be a top down process. The first step is to determine the total amount of risk, as measured by VaR, that the firm is willing to accept. The next step is to choose the optimal allocation of assets for that risk exposure. As an example, a firm's management might set a return volatility target equal to 20%. If the firm has $100 million in assets under management and assuming the returns are normally distributed, at a 95% confidence level, this translates to:

$$\text{VaR} = (1.65) \times (20\%) \times (\$100 \text{ million}) = \$33 \text{ million}$$

The goal will be to choose assets for the fund that keep VaR less than this value. Unless the asset classes are perfectly correlated, the sum of the VaRs of the individual assets will be greater than the actual VaR of the portfolio. Thus, the budgeting of risk across asset classes should take into account the diversification effects. Such effects can be carried down to the next level when selecting the individual assets for the different classes.

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Example: Budgeting risk across asset classes (part 1)

A manager has a portfolio with only one position: a $500 million investment in W. The manager is considering adding a $500 million position X or Y to the portfolio. The current volatility of W is 10%. The manager wants to limit portfolio VaR to $200 million at the 99% confidence level. Position X has a return volatility of 9% and a correlation with W equal to 0.7. Position Y has a return volatility of 12% and a correlation with W equal to zero. **Determine** which of the two proposed additions, X or Y, will keep the manager within his risk budget.

Answer:

Currently, the VaR of the portfolio with only W is:

$$\text{VaR}_W = (2.33)(10\%)(\$500 \text{ million}) = \$116.5 \text{ million}$$

When adding X, the return volatility of the portfolio will be:

$$8.76\% = \sqrt{(0.5^2)(10\%)^2 + (0.5^2)(9\%)^2 + (2)(0.5)(0.5)(0.7)(10\%)(9\%)}$$

$$\text{VaR}_{W+X} = 2.33(8.76\%)(\$1{,}000 \text{ million}) = \$204 \text{ million}$$

When adding Y, the return volatility of the portfolio will be:

$$7.81\% = \sqrt{(0.5^2)(10\%)^2 + (0.5^2)(12\%)^2}$$

$$\text{VaR}_{W+Y} = (2.33)(7.81\%)(\$1{,}000 \text{ million}) = \$182 \text{ million}$$

Thus, Y keeps the total portfolio within the risk budget.

Example: Budgeting risk across asset classes (part 2)

In the previous example, **demonstrate** why focusing on the stand-alone VaR of X and Y would have led to the wrong choice.

Answer:

Obviously, the VaR of X is less than that of Y.

$$\text{VaR}_X = (2.33)(9\%)(\$500 \text{ million}) = \$104.9 \text{ million}$$

$$\text{VaR}_Y = (2.33)(12\%)(\$500 \text{ million}) = \$139.8 \text{ million}$$

The individual VaRs would have led the manager to select X over Y; however, the high correlation of X with W gives X a higher incremental VaR, which puts the portfolio of W and X over the limit. The zero correlation of W and Y makes the incremental VaR of Y much lower, and the portfolio of W with Y keeps the risk within the limit.

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The traditional method for evaluating active managers is by measuring their excess return and tracking error and using it to derive a measure known as the information ratio. Excess return is the active return minus the benchmark return. The **information ratio** of manager *i* is:

$$IR_i = \frac{\text{(expected excess return of the manager)}}{\text{(the manager's tracking error)}}$$

For a portfolio of funds, each managed by a separate manager, the top management of the entire portfolio would be interested in the portfolio information ratio:

$$IR_P = \frac{\text{(expected excess return of the portfolio)}}{\text{(the portfolio's tracking error)}}$$

If the excess returns of the managers are independent of each other, it can be shown that the optimal allocation across managers is found by allocating weights to managers according to the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$$

One way to use this measure is to "budget" portfolio tracking error. Given the IR_P, the IR_i, and the manager's tracking error, top management can calculate the respective weights to assign to each manager. The weights of the allocations to the managers do not necessarily have to sum to one. Any difference can be allocated to the benchmark itself because, by definition, $IR_{benchmark} = 0$.

Determining the precise weights will be an iterative process in that each selection of weights will give a different portfolio expected excess return and tracking error. Figure 2 illustrates a set of weights derived from the given inputs that satisfy the condition.

Figure 2: Budgeting Risk Across Active Managers

	Tracking Error	*Information Ratio*	*Weights*
Manager A	5.0%	0.70	51%
Manager B	5.0%	0.50	37%
Benchmark	0.0%	0.00	12%
Portfolio	3.0%	0.82	100%

Although we have skipped the derivation, we can see that the conditions for optimal allocation hold true:

$$\text{For A: } 51\% = \frac{(3\%)(0.70)}{(5\%)(0.82)}$$

$$\text{For B: } 37\% = \frac{(3\%)(0.50)}{(5\%)(0.82)}$$

The difference between 100% and the sum of the weights 51% and 37% is the 12% invested in the benchmark.

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Key Concepts

LO 63.1

Risk budgeting is a top-down process that involves choosing and managing exposures to risk.

LO 63.2

Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. They have tended to use historical risk measures and focus on tracking error, benchmarking, and investment guidelines. Banks use forward-looking VaR risk measures and VaR limits. Investors seem to be using VaR more and more, but they have to adapt it to their needs.

LO 63.3

Investors are relying more on VaR because of increased globalization, complexity, and dynamics of the investment industry. They have found simply measuring risk from historical measures is no longer adequate.

LO 63.4

Hedge funds have risk characteristics that make them more similar to the "sell side" of the industry like the use of leverage and high turnover. In addition to that, they have other risks such as low liquidity and low transparency. Low liquidity leads to problems in measuring risk because it tends to put a downward bias on volatility and correlation measures.

LO 63.5

Absolute or asset risk refers to the total possible losses over a horizon. Relative risk is measured by excess return, which is the dollar loss relative to a benchmark. VaR measures can apply to both.

The risk from the policy mix is from the chosen portfolio weights, and active risk is from individual managers deviating from the chosen portfolio weights.

Funding risk is the risk that the value of assets will not be sufficient to cover the liabilities of the fund. It is important for pension funds. In applying VaR, a manager will add the expected increase in the surplus to the surplus and subtract the VaR of the assets from it. The difference between the expected surplus and the portfolio VaR is the shortfall associated with the VaR.

Two components of sponsor risk are cash-flow risk, which addresses variations of contributions to the fund, and economic risk, which is the variation of the earnings.

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LO 63.6

Risk monitoring is important in large firms to catch "rogue traders" whose activities may go undetected with simple periodic statements. It is also needed for passive portfolios because the risk characteristics of the benchmarks can change. Risk monitoring can also determine why changes in risk have occurred (e.g., individual managers exceeding their budget, different managers taking on the same exposures, or the risk characteristics of the whole market changing).

There is a trend toward using a global custodian in the risk management of investment firms. It is an easy means to the goal of centralized risk management. The custodians can combine reports on changes in positions with market data to produce forward-looking risk measures. Those that choose not to use a global custodian have done so because they feel they have tighter control over risk measures and can better incorporate VaR systems into operations.

LO 63.7

There is a trend of investment managers incorporating VaR systems into their investment management process. There is evidence that money managers are differentiating themselves with respect to their risk management systems, and those that do not use such systems are at a competitive disadvantage.

VaR techniques can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Such guidelines are cumbersome and ineffective in that they focus on individual positions and can be easily circumvented.

VaR is useful for the investment process. When a trader has a choice between two new positions for a portfolio, the trader can compare the marginal VaRs to make the selection. When deciding whether to increase one existing position over another, the trader can compare the excess-return-to-MVaR ratios and increase the position in the one with the higher ratio.

LO 63.8

Budgeting risk across asset classes means selecting assets whose combined VaRs are less than the total allowed. The budgeting process would examine the contribution each position makes to the portfolio VaR.

For allocating across active managers, it can be shown that the optimal allocation is achieved with the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{\text{IR}_i \times (\text{portfolio's tracking error})}{\text{IR}_P \times (\text{manager's tracking error})}$$

For a given group of active managers, the weights may not sum to one. The remainder of the weight can be allocated to the benchmark, which has no tracking error.

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Concept Checkers

1. With respect to the buy side and sell side of the investment industry:

   I. the buy side uses more leverage.
   II. the sell side has relied more on VaR measures.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

2. Compared to policy risk, which of the following is not a reason that management risk is not much of a problem?
   A. There will be diversification effects across the deviations.
   B. Managers tend to make the same style shifts at the same time.
   C. For well-managed funds, it is usually fairly small for each of the individual funds.
   D. There can be diversification with the policy mix VaR to actually lower the total portfolio VaR.

3. Using VaR to monitor risk is important for a large firm with many types of managers because:
   A. it can help catch rogue traders and it can detect changes in risk from changes in benchmark characteristics.
   B. although it cannot help catch rogue traders, it can detect changes in risk from changes in benchmark characteristics.
   C. although it cannot detect changes in risk from changes in benchmark characteristics, it can help detect rogue traders.
   D. of no reason. VaR is not useful for monitoring risk in large firms.

4. VaR can be used to compose better guidelines for investment companies by:

   I. relying less on notionals.
   II. focusing more on overall risk.

   A. I only.
   B. II only
   C. Both I and II.
   D. Neither I nor II.

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5. In making allocations across active managers, which of the following represents the formula that gives the optimal weight to allocate to a manager denoted *i*, where IR_i and IR_P are the information ratios of the manager and the total portfolio respectively?

A. $\dfrac{IR_P \times (\text{portfolio's tracking error})}{IR_i \times (\text{manager's tracking error})}$.

B. $\dfrac{IR_i \times (\text{manager's tracking error})}{IR_P \times (\text{portfolio's tracking error})}$.

C. $\dfrac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$.

D. $\dfrac{IR_P \times (\text{manager's tracking error})}{IR_i \times (\text{portfolio's tracking error})}$.

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Concept Checker Answers

1. **B** Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. Banks use forward-looking VaR risk measures and VaR limits.

2. **B** If managers make the same style shifts, then that would actually increase management risk. All the other reasons are valid.

3. **A** Both of these are reasons large firms find VaR and risk monitoring useful.

4. **C** Investment companies have been focusing on limits on notionals, which is cumbersome and has proved to be ineffective.

5. **C** $\text{weight of portfolio managed by manager } i = \dfrac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Risk Monitoring and Performance Measurement

Topic 64

Exam Focus

Most of this topic is qualitative in nature, however, it does contain several testable concepts. Many of the concepts covered here are also covered in other assigned readings, so this topic should serve as reinforcement of those concepts. For the exam, focus on the three pillars of effective risk management: planning, budgeting, and monitoring. Understand the concept of a risk management unit (RMU) and be able to discuss its appropriate role within a company. Always keep in mind while reviewing this topic that it is the amount of risk taken that ultimately drives the level of returns—risk is the "cost" of returns.

Risk Measures

LO 64.1: Define, compare and contrast VaR and tracking error as risk measures.

Value at risk (VaR) is defined to be the *largest* loss possible for a *certain* level of confidence over a *specific* period of time. For example, a firm could express its VaR as being 95% certain that they will lose a maximum of $5 million in the next ten days. Delta-normal VaR assumes a normal distribution, and its calculation reflects losses in the lower tail of the returns distribution.

Tracking error is defined as the standard deviation of excess returns. Excess return is defined as the portfolio return less the benchmark return (i.e., alpha). Assuming a normal distribution of excess returns, 95% of the outcomes will fall within the mean benchmark return plus or minus roughly two standard deviations.

VaR and tracking error are both measures of risk. An organization's objective is to maximize profits for a given level of risk taken. Too much risk taken (in comparison with budget) suggests a VaR level that is too high and a willingness to accept large losses to produce unnecessarily high returns. Too little risk taken suggests that there is not enough active management, and actual returns will fall short of budgeted returns.

VaR may be used to suggest the maximum dollar value of losses for a specific level of confidence over a specific time. From a portfolio management perspective, VaR could be determined for each asset class, and capital allocation decisions could be made amongst the asset classes depending on risk and return preferences. This will help to achieve targeted levels of dollar VaR. In contrast, tracking error may be used to determine the relative amount of discretion that can be taken by the portfolio manager (away from benchmark returns) in his or her attempts at active management.

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Risk Planning

LO 64.2: Describe risk planning, including its objectives, effects and the participants in its development.

There are five risk planning objectives for any entity to consider.

1. Setting expected return and expected volatility goals.

   Examples of an entity's goals could include specifying the acceptable amounts of VaR and tracking error for a given period of time. Scenario analysis could be employed to determine potential sources of failure in the plan as well as ways to respond should those sources occur.

2. Defining quantitative measures of success or failure.

   Specific guidelines should be stated. For example, one could state an acceptable level of return on equity (ROE) or return on risk capital (RORC). This would help regulatory agencies assess the entity's success or failure from a risk management perspective.

3. Generalizing how risk capital will be utilized to meet the entity's objectives.

   Objectives relating to return per unit of risk capital need to be defined. For example, the minimum acceptable RORC should be defined for each activity where risk is allocated from the budget. The correlations between the RORCs should also be considered within an entity-wide risk diversification context.

4. Defining the difference between events that cause ordinary damage versus serious damage.

   Specific steps need to be formulated to counter any event that threatens the overall long-term existence of the entity, even if the likelihood of occurrence is remote. The choice between seeking external insurance (i.e., put options) versus self-insurance for downside portfolio risk has to be considered from a cost-benefit perspective, taking into account the potential severity of the losses.

5. Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

   Examples of such resources would include key employees and financing sources. Scenario analysis should be employed to assess the impact on those resources in both good and bad times. Specifically, adverse events often occur together with other adverse (and material) events.

In general, the risk planning process frequently requires the input and approval of the entity's owners and its management team. An effective plan requires very active input from the entity's highest level of management so as to ensure risk and return issues are addressed, understood, and communicated within the entity, to key stakeholders, and to regulatory agencies.

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Risk Budgeting

LO 64.3: Describe risk budgeting and the role of quantitative methods in risk budgeting.

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the entity's objectives and minimize deviations from the plan. Each specific allocation from the risk budget comes with a reasonable return expectation. The return expectation comes with an estimate of variability around that expectation.

With risk budgets, an amount of VaR could be calculated for each item on the income statement. This allows RORC to be calculated individually and in aggregate.

Quantitative methods (i.e., mathematical modeling) may be used in risk budgeting as follows:

1. Set the minimum acceptable levels of RORC and ROE over various time periods. This is to determine if there is sufficient compensation for the risks taken (i.e., risk-adjusted profitability).
2. Apply mean-variance optimization (or other quantitative methods) to determine the weights for each asset class.
3. Simulate the portfolio performance based on the weights above and for several time periods. Apply sensitivity analysis to the performance by considering changes in estimates of returns and covariances.

Risk Monitoring

LO 64.4: Describe risk monitoring and its role in an internal control environment.

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget. This is to ensure, for example, that there are no threats to meeting its ROE and RORC targets. Risk monitoring is useful in that it should detect and address any significant variances in a timely manner.

LO 64.5: Identify sources of risk consciousness within an organization.

The increasing sense of risk consciousness within and among organizations is mainly derived from the following three sources:

1. *Banks* who lend funds to investors are concerned with where those funds are invested.
2. *Boards of investment clients, senior management, and plan sponsors* have generally become more versed in risk management issues and more aware of the need for effective oversight over asset management activities.

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3. *Investors* have become more knowledgeable about their investment choices. For example, beneficiaries of a defined contribution plan are responsible for selecting their individual pension investments.

LO 64.6: Describe the objectives and actions of a risk management unit in an investment management firm.

A **risk management unit** (RMU) monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function has an independent reporting line to senior management.

The objectives of a RMU include:

- Gathering, monitoring, analyzing, and distributing risk data to managers, clients, and senior management. Accurate and relevant information must be provided to the appropriate person(s) at the appropriate time(s).
- Assisting the entity in formulating a systematic and rigorous method as to how risks are identified and dealt with. Promotion of the entity's risk culture and best risk practices is crucial here.
- Going beyond merely providing information by taking the initiative to research relevant risk topics that will affect the firm.
- Monitoring trends in risk on a continual basis and promptly reporting unusual events to management before they become significant problems.
- Promoting discussion throughout the entity and developing a process as to how risk data and issues are discussed and implemented within the entity.
- Promoting a greater sense of risk awareness (culture) within the entity.
- Ensuring that transactions that are authorized are consistent with guidance provided to management and with client expectations.
- Identifying and developing risk measurement and performance attribution analytical tools.
- Gathering risk data to be analyzed in making portfolio manager assessments and market environment assessments.
- Providing the management team with information to better comprehend risk in individual portfolios as well as the source of performance.
- Measuring risk within an entity. In other words, measuring how consistent portfolio managers are with respect to product objectives, management expectations, and client objectives. Significant deviations are brought to the attention of appropriate management to provide a basis for correction.

Professor's Note: You may see references elsewhere to an Independent Risk Oversight Unit. This is the same concept as RMU. Both measure and manage risk exposure and operate as an independent business unit.

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LO 64.7: Describe how risk monitoring can confirm that investment activities are consistent with expectations.

Is the manager generating a forecasted level of tracking error that is consistent with the target?

The forecasted tracking error is an approximation of the potential risk of a portfolio using statistical methods. For each portfolio, the forecast should be compared to budget using predetermined guidelines as to how much variance is acceptable, how much variance requires further investigation, and how much variance requires immediate action. Presumably, the budget was formulated taking into account client expectations.

Tracking error forecast reports should be produced for all accounts that are managed similarly in order to gauge the consistency in risk levels taken by the portfolio manager.

Is risk capital allocated to the expected areas?

Overall tracking risk is not sufficient as a measure on its own; it is important to break down the tracking risk into "subsections." If the analysis of the risk taken per subsection does not suggest that risk is being incurred in accordance with expectations, then there may be **style drift**. Style drift may manifest itself in a value portfolio manager who attains the overall tracking error target but allocates most of the risk (and invests) in growth investments.

Therefore, by engaging in risk decomposition, the RMU may ensure that a portfolio manager's investment activities are consistent with the predetermined expectations (i.e., stated policies and manager philosophy). Also, by running the report at various levels, unreasonably large concentrations of risk (that may jeopardize the portfolio) may be detected.

Liquidity Considerations

LO 64.8: Explain the importance of liquidity considerations for a portfolio.

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance. Therefore, measuring portfolio liquidity is a priority in stress testing.

One potential measure is **liquidity duration**. It is an approximation of the number of days necessary to dispose of a portfolio's holdings without a significant market impact. For a given security, the liquidity duration could be calculated as follows:

$$LD = \frac{Q}{(0.10 \times V)}$$

where:
LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

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Performance Measurement

LO 64.9: Describe the objectives of performance measurement.

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups. Therefore, performance measurement seeks to determine whether a manager can consistently outperform (through excess returns) the benchmark on a risk-adjusted basis. Similarly, it seeks to determine whether a manager consistently outperforms its peer group on a risk-adjusted basis.

Furthermore, performance measurement may help to determine whether the returns achieved are commensurate with the risk taken. Finally, performance measurement provides a basis for identifying managers who are able to generate consistent excess risk-adjusted returns. Such superior processes and performance could be replicated on an on-going basis, thereby maximizing the entity's long-run returns and profitability.

Comparison of Performance with Expectations

From a risk perspective (e.g., tracking error), portfolio managers should be assessed on the basis of being able to produce a portfolio with risk characteristics that are expected to approximate the target. In addition, they should also be assessed on their ability to actually achieve risk levels that are close to target.

From a returns perspective (e.g., performance), portfolio managers could be assessed on their ability to earn excess returns.

Goldman Sachs Asset Management utilizes a so-called "green zone" to identify instances of actual tracking error or performance that are outside of normal expectations. An acceptable amount of deviation (from a statistical perspective) is determined, and any deviations up to that amount are considered a green zone event. Unusual events that are expected to occur with some regularity are considered "yellow zone" events. Truly unusual events that require immediate investigation are considered "red zone" events. In using this simple color-coded system, the various zones are predefined and provide clear expectations for the portfolio managers. The movements of portfolios into yellow or red zones are triggering events that require further investigation and discussion.

Return Attribution

The source of returns can be attributed to specific factors or securities. For example, it is important to ensure that returns result from decisions where the manager intended to take risk and not simply from sheer luck.

Variance analysis is used to illustrate the contribution to overall portfolio performance by each security. The securities can be regrouped in various ways to conduct analysis by industry, sector, and country, for example.

In performing return attribution, factor risk analysis and factor attribution could be used. Alternatively, risk forecasting and attribution at the security level could also be used.

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Sharpe and Information Ratio

The **Sharpe ratio** is calculated by taking the portfolio's actual return and subtracting the risk-free rate in the numerator. The denominator is the portfolio's standard deviation. The **information ratio** is calculated by taking the portfolio's excess returns and subtracting the benchmark's excess returns (if applicable) in the numerator. The denominator is the portfolio's tracking error. These two measures are both considered risk-adjusted return measures.

Strengths of these metrics include the following: (1) easy to use as a measure of relative performance compared to a benchmark or peer group; (2) easy to determine if the manager has generated sufficient excess returns in relation to the amount of risk taken; and (3) easy to apply to industrial sectors and countries.

Weaknesses of these metrics include the following: (1) insufficient data available to perform calculations; and (2) the use of realized risk (instead of potential risk) may result in overstated performance calculations.

Comparisons with Benchmark Portfolios and Peer Groups

One could use linear regression analysis to regress the excess returns of the investment against the excess returns of the **benchmark**. One of the outputs from this regression is **alpha**, and it could be tested for statistical significance to determine whether the excess returns are attributable to manager skill or just pure luck. The other output is **beta**, and it relates to the amount of leverage used or underweighting/overweighting in the market compared to the benchmark.

The regression also allows a comparison of the absolute amount of excess returns compared to the benchmark. Furthermore, there is the ability to separate excess returns due to leverage and excess returns due to skill. One limitation to consider is that there may not be enough data available to make a reasonable conclusion as to the manager's skill.

One could also regress the excess returns of the manager against the excess returns of the manager's **peer group**. The features of this regression are generally similar to that for the benchmark above, except that the returns of the peer group suffer from **survivorship bias**, and there is usually a wide range of funds under management amongst the peers (that reduces the comparability).

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Key Concepts

LO 64.1

VaR and tracking error are both measures of risk. VaR is defined to be the largest loss possible for a certain level of confidence over a specific period of time. Tracking error is defined as the standard deviation of excess returns.

LO 64.2

There are five risk planning objectives to consider.

- Setting expected return and expected volatility goals.
- Defining quantitative measures of success or failure.
- Generalizing how risk capital will be utilized to meet the entity's objectives.
- Defining the difference between events that cause ordinary damage versus serious damage.
- Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

The risk planning process frequently requires the input and approval of the entity's owners and its management team.

LO 64.3

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the corporate objectives and minimize deviations from plan.

Quantitative methods may be used in risk budgeting. Activities include: setting the minimum acceptable levels of RORC and ROE, applying mean-variance optimization, simulating portfolio performance, and applying sensitivity analysis.

LO 64.4

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget.

LO 64.5

Sources of risk consciousness include: (1) banks, (2) boards of investment clients, senior management, and plan sponsors, and (3) investors.

LO 64.6

A risk management unit (RMU) monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function be independent and not report to senior management.

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LO 64.7

The risk monitoring process attempts to confirm that investment activities are consistent with expectations. Specifically, is the manager generating a forecasted level of tracking error that is consistent with the target? And is risk capital allocated to the expected areas?

LO 64.8

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance.

LO 64.9

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups.

A performance measurement framework includes: (1) comparison of performance with expectations, (2) return attribution, (3) calculation of metrics such as the Sharpe ratio and the information ratio, and (4) comparisons with benchmark portfolios and peer groups.

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Concept Checkers

1. Which of the following statements about tracking error and value at risk (VaR) is least accurate?
   A. Tracking error and VaR are complementary measures of risk.
   B. Both tracking error and VaR may assume a normal distribution of returns.
   C. Tracking error is the standard deviation of the excess of portfolio returns over the return of the peer group.
   D. VaR can be defined as the maximum loss over a given time period.

2. Which of the following statements about the use of quantitative methods in risk budgeting is least accurate? They may be used:
   A. to simulate the performance of portfolios.
   B. to set levels of return on equity (ROE) and return on risk capital (RORC).
   C. in a scenario analysis context to determine the weights for each asset class.
   D. in a sensitivity analysis context to consider changes in estimates of returns and covariances.

3. A risk management unit (RMU) is most likely to be active in which of the following contexts?
   A. Risk monitoring.
   B. Risk measurement.
   C. Risk budgeting.
   D. Risk planning.

4. Which of the following statements does not help explain the purpose of risk decomposition?
   A. To ensure that there is no style drift.
   B. To detect large concentrations of risk.
   C. To detect excessive amounts of tracking risk.
   D. To ensure that investment activities are consistent with expectations.

5. Which of the following statements regarding alphas and betas is incorrect?
   A. Alpha is the excess return attributable to pure luck.
   B. Alpha is the excess return attributable to managerial skill.
   C. Beta suggests the relative amount of leverage used.
   D. Beta suggests whether some of the returns are attributable to over or under weighting the market.

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Concept Checker Answers

1. **C** All of the statements are accurate with the exception of the one relating to the peer group. Tracking error is the standard deviation of the excess of portfolio returns over the return of an appropriate benchmark, not peer group.

2. **C** All of the statements are accurate with the exception of the one relating to scenario analysis. One should apply mean-variance optimization (and not scenario analysis) to determine the weights for each asset class.

3. **A** A RMU monitors an investment management firm's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set.

4. **C** Risk decomposition is not designed to detect excessive amounts of tracking risk. In fact, it is the forecasted tracking error amount that should be compared to budget to ensure that there is not excessive tracking risk. All the other reasons are consistent with the purpose of risk decomposition.

5. **A** Alpha is a measure of the excess return of a manager over the peer group/benchmark that relates to skill as opposed to pure luck. Beta is a measure of the amount of leverage used compared to the peer group or a measure of the underweighting or overweighting of the market compared to the benchmark.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Portfolio Performance Evaluation

Topic 65

Exam Focus

Professional money managers are routinely evaluated using a wide array of metrics. In this topic, alternative methods of computing portfolio returns will be presented, and contrasts will be made between time-weighted and dollar-weighted returns for portfolios experiencing cash redemptions and contributions. For the exam, be sure to understand differences in the risk-adjusted performance measures, including the Sharpe ratio, Treynor ratio, Jensen's alpha, information ratio, and M^2, and how the trading practices of hedge funds complicates the evaluation process. Be able to apply Sharpe's regression-based style analysis to conduct performance attributions.

Time-Weighted and Dollar-Weighted Returns

LO 65.1: Differentiate between time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses.

The **dollar-weighted rate of return** is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

Example: Dollar-weighted rate of return

Assume an investor buys a share of stock for \$100 at t = 0, and at the end of the next year (t = 1), she buys an additional share for \$120. At the end of year 2, the investor sells both shares for \$130 each. At the end of each year in the holding period, the stock paid a \$2.00 per share dividend. What is the investor's dollar-weighted rate of return?

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Answer:

Step 1: Determine the timing of each cash flow and whether the cash flow is an inflow (+) or an outflow (–).

t = 0:	purchase of first share	=	–$100
t = 1:	dividend from first share	=	+$2
	purchase of second share	=	<u>–$120</u>
	subtotal, t = 1		–$118
t = 2:	dividend from two shares	=	+$4
	proceeds from selling shares	=	<u>+$260</u>
	subtotal, t = 2		+$264

Step 2: Net the cash flows for each time period, and set the PV of cash inflows equal to the present value of cash outflows.

$$PV_{inflows} = PV_{outflows}$$

$$\$100 + \frac{\$120}{(1+r)} = \frac{\$2}{(1+r)} + \frac{\$264}{(1+r)^2}$$

Step 3: Solve for *r* to find the dollar-weighted rate of return. This can be done using trial and error or by using the IRR function on a financial calculator or spreadsheet.

The intuition here is that we deposited $100 into the account at t = 0, then added $118 to the account at t = 1 (which, with the $2 dividend, funded the purchase of one more share at $120), and ended with a total value of $264.

To compute this value with a financial calculator, use these net cash flows and follow the procedure described in Figure 1 to calculate the IRR.

Net cash flows: CF_0 = –100; CF_1 = –120 + 2 = –118; CF_2 = 260 + 4 = 264

Figure 1: Calculating Dollar-Weighted Return with the TI Business Analyst II Plus® Calculator

Key Strokes	*Explanation*	*Display*
[CF] [2nd] [CLR WORK]	Clear cash flow registers	CF0 = 0.00000
100 [+/–] [ENTER]	Initial cash outlay	CF0 = –100.00000
[↓] 118 [+/–] [ENTER]	Period 1 cash flow	C01 = –118.00000
[↓] [↓] 264 [ENTER]	Period 2 cash flow	C02 = 264.00000
[IRR] [CPT]	Calculate IRR	IRR = 13.86122

The dollar-weighted rate of return for this problem is 13.86%.

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Time-weighted rate of return measures compound growth. It is the rate at which $1.00 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time. The *annual* time-weighted return for an investment may be computed by performing the following steps:

Step 1: Value the portfolio immediately preceding significant addition or withdrawals. Form subperiods over the evaluation period that correspond to the dates of deposits and withdrawals.

Step 2: Compute the holding period return (HPR) of the portfolio for each subperiod.

Step 3: Compute the product of $(1 + HPR_t)$ for each subperiod t to obtain a total return for the entire measurement period [i.e., $(1 + HPR_1) \times (1 + HPR_2) \ldots (1 + HPR_n)$]. If the total investment period is greater than one year, you must take the geometric mean of the measurement period return to find the annual time-weighted rate of return.

Example: Time-weighted rate of return

A share of stock is purchased at t = 0 for $100. At the end of the next year, t = 1, another share is purchased for $120. At the end of year 2, both shares are sold for $130 each. At the end of years 1 and 2, the stock paid a $2.00 per share dividend. What is the time-weighted rate of return for this investment? (This is the same data as presented in the dollar-weighted rate-of-return example.)

Answer:

Step 1: Break the evaluation period into two subperiods based on timing of cash flows.

Holding period 1:	beginning price	= $100.00
	dividends paid	= $2.00
	ending price	= $120.00
Holding period 2:	beginning price	= $240.00 (2 shares)
	dividends paid	= $4.00 ($2 per share)
	ending price	= $260.00 (2 shares)

Step 2: Calculate the HPR for each holding period.

HPR_1 = [($120 + 2) / $100] – 1 = 22%

HPR_2 = [($260 + 4) / $240] – 1 = 10%

Step 3: Take the geometric mean of the annual returns to find the annualized time-weighted rate of return over the measurement period.

$$(1 + \text{time-weighted rate of return})^2 = (1.22)(1.10)$$

$$\text{time-weighted rate of return} = \left[\sqrt{(1.22)(1.10)}\right] - 1 = 15.84\%$$

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In the investment management industry, the time-weighted rate of return is the preferred method of performance measurement for a portfolio manager because it is not affected by the timing of cash inflows and outflows, which may be beyond the manager's control.

In the preceding examples, the time-weighted rate of return for the portfolio was 15.84%, while the dollar-weighted rate of return for the same portfolio was 13.86%. The difference in the results is attributable to the fact that the procedure for determining the dollar-weighted rate of return gave a larger weight to the year 2 HPR, which was 10% versus the 22% HPR for year 1.

If funds are contributed to an investment portfolio just before a period of relatively poor portfolio performance, the dollar-weighted rate of return will tend to be depressed. Conversely, if funds are contributed to a portfolio at a favorable time, the dollar-weighted rate of return will increase. The use of the time-weighted return removes these distortions, providing a better measure of a manager's ability to select investments over the period. If a private investor has complete control over money flows into and out of an account, the dollar-weighted rate of return may be the more appropriate performance measure.

Therefore, the dollar-weighted return will exceed the time-weighted return for a manager who has superior market timing ability.

Risk-Adjusted Performance Measures

LO 65.2: Describe and distinguish between risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and information ratio.

LO 65.3: Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios, and the graphical representation of these measures.

Universe Comparisons

Portfolio rankings based merely on returns ignore differences in risk across portfolios. A popular alternative is to use a comparison universe. This approach classifies portfolios according to investment style (e.g., small cap growth, small cap value, large cap growth, large cap value) and, then, ranks portfolios based on rate of return within the appropriate style universe. The rankings are now more meaningful because they have been standardized on the investment style of the funds. This method will fail, however, if risk differences remain across the funds within a given style.

The Sharpe Ratio

The **Sharpe ratio** uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk. Hence, the Sharpe ratio evaluates the performance of the portfolio in terms of both overall return and diversification.

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The Sharpe ratio is defined as:

$$S_A = \frac{\overline{R}_A - \overline{R}_F}{\sigma_A}$$

where:

$\overline{R}_A$ = average account return

$\overline{R}_F$ = average risk-free return

σ_A = standard deviation of account returns

Professor's Note: Again, the risk measure, standard deviation, should ideally be the actual standard deviation during the measurement period.

The Treynor Measure

The **Treynor measure** is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

The Treynor measure is defined as:

$$T_A = \frac{\overline{R}_A - \overline{R}_F}{\beta_A}$$

where:

$\overline{R}_A$ = average account return

$\overline{R}_F$ = average risk-free return

β_A = average beta

Professor's Note: Ideally, the Treynor measure should be calculated using the actual beta for the portfolio over the measurement period. Since beta is subject to change due to varying covariance with the market, using the premeasurement period beta may not yield reliable results. The beta for the measurement period is estimated by regressing the portfolio's returns against the market returns.

For a well-diversified portfolio, the difference in risk measurement between the Sharpe ratio and the Treynor measure becomes irrelevant as the total risk and systematic risk will be very close. For a less than well-diversified portfolio, however, the difference in rankings based on the two measures is likely due to the amount of diversification in the portfolio. Used along with the Treynor measure, the Sharpe ratio provides additional information about the degree of diversification in a portfolio.

Sharpe vs. Treynor. If a portfolio was not well-diversified over the measurement period, it may be ranked relatively higher using Treynor than using Sharpe because Treynor considers only the beta (i.e., systematic risk) of the portfolio over the period. When the Sharpe ratio is calculated for the portfolio, the excess total risk (standard deviation) due to diversifiable risk will cause rankings to be lower. Although we do not get an absolute measure of the lack of

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diversification, the change in the rankings shows the presence of unsystematic risk, and the greater the difference in rankings, the less diversified the portfolio.

Jensen's Alpha

Jensen's alpha, also known as Jensen's measure, is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return. Jensen's alpha is a direct measure of performance (i.e., it yields the performance measure without being compared to other portfolios).

$$\alpha_A = R_A - E(R_A)$$

where:
α_A = alpha
R_A = the return on the account
$E(R_A) = R_F + \beta_A[E(R_M) - R_F]$

A superior manager would have a statistically significant and positive alpha. Jensen's alpha uses the portfolio return, market return, and risk-free rate for each time period separately. The Sharpe and Treynor measures use only the average of portfolio return and risk-free rate. Furthermore, like the Treynor measure, Jensen's alpha only takes into account the systematic risk of the portfolio and, hence, gives no indication of the diversification in the portfolio.

Information Ratio

The Sharpe ratio can be changed to incorporate an appropriate benchmark instead of the risk-free rate. This form is known as the **information ratio** or **appraisal ratio**:

$$IR_A = \frac{\overline{R}_A - \overline{R}_B}{\sigma_{A-B}}$$

where:
$\overline{R}_A$ = average account return
$\overline{R}_B$ = average benchmark return
σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken (denominator) to achieve a certain level of return above the benchmark (numerator). An active manager makes specific cognitive bets to achieve a positive surplus return. The variability in the surplus return is a measure of the risk taken to achieve the surplus. The ratio computes the surplus return relative to the risk taken. A higher information ratio indicates better performance.

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Professor's Note: The version of the information ratio presented here is the most common. However, you should be aware that an alternative calculation of this ratio exists that uses alpha over the expected level of unsystematic risk over the time period, $\frac{\alpha_A}{\sigma(\varepsilon_A)}$.

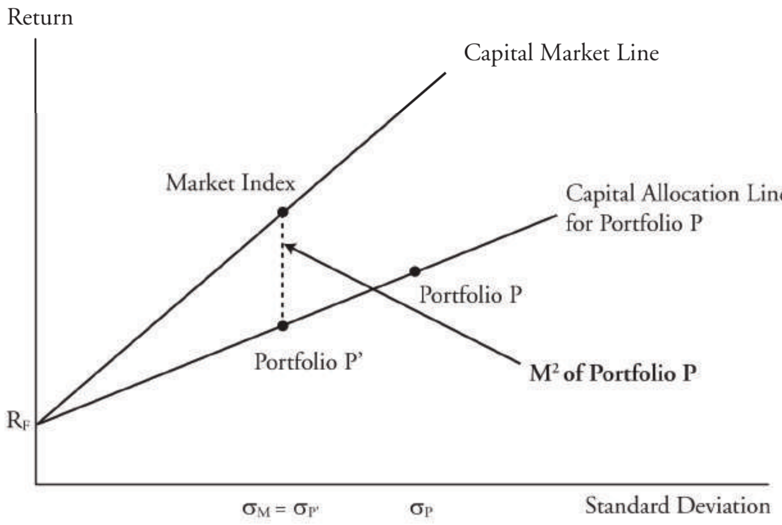
M-Squared (M^2) Measure

A relatively new measure of portfolio performance developed by Leah Modigliani and her grandfather, 1985 Nobel Prize recipient Franco Modigliani, has become quite popular. The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

Professor's Note: There are no squared terms in the M-squared calculation. The term "M-squared" merely refers to the last names of its originators (Leah and Franco Modigliani).

The M^2 measure can be illustrated with a graph comparing the capital market line for the market index and the capital allocation line for managed Portfolio P. In Figure 2, notice that Portfolio P has a higher standard deviation than the market index. But, we can easily create a Portfolio P' that has standard deviation equal to the market standard deviation by investing appropriate percentages in both the risk-free asset and Portfolio P. The difference in return between Portfolio P' and the market portfolio, equals the M^2 measure for Portfolio P.

Figure 2: The M^2 Measure of Portfolio Performance



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Example: Calculating the M^2 performance measure

Calculate the M^2 measure for Portfolio P:

• Portfolio P mean return	10%
• Portfolio P standard deviation	40%
• Market portfolio mean return	12%
• Market portfolio standard deviation	20%
• Risk-free rate	4%

Answer:

To answer the question, first note that a portfolio, P', can be created that allocates 50/50 to the risk-free asset and to Portfolio P such that the standard deviation of Portfolio P' equals the standard deviation of the market portfolio:

$$\sigma_{P'} = w_P \sigma_P = 0.50(0.40) = 0.20$$

Therefore, a 50/50 allocation between Portfolio P and the risk-free asset provides risk identical to the market portfolio. What is the difference in return between Portfolio P' and the market portfolio? To answer this question, first we must derive the mean return on Portfolio P':

$$R_{P'} = w_F R_F + w_P R_P = 0.50(0.04) + 0.50(0.10) = 0.07$$

Alternatively, the mean return for Portfolio P' can be derived by using the equation of the capital allocation line for Portfolio P:

$$R_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_M$$

$$= 0.04 + \left(\frac{0.10 - 0.04}{0.40}\right)0.20 = 0.04 + (0.15)0.20 = 0.07$$

Therefore, we now have created a portfolio, P', that matches the risk of the market portfolio (standard deviation equals 20%). All that remains is to calculate the difference in returns between Portfolio P' and the market portfolio:

$$M^2 = R_{P'} - R_M = 0.07 - 0.12 = -0.05$$

Clearly, Portfolio P is a poorly performing portfolio. After controlling for risk, Portfolio P provides a return that is 5 percentage points below the market portfolio.

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Professor's Note: Unfortunately, a consistent definition of M^2 does not exist. Sometimes M^2 is defined as equal to the return on the risk-adjusted Portfolio P' rather than equal to the difference in returns between P' and M. However, portfolio rankings based on the return on P' or on the difference in returns between P' and M will be identical. Therefore, both definitions provide identical portfolio performance rankings.

M^2 will produce the same conclusions as the Sharpe ratio. As stated earlier, Jensen's alpha will produce the same conclusions as the Treynor measure. However, M^2 and Sharpe may not give the same conclusion as Jensen's alpha and Treynor. A discrepancy could occur if the manager takes on a large proportion of unsystematic risk relative to systematic risk. This would lower the Sharpe ratio but leave the Treynor measure unaffected.

Example: Risk-adjusted performance appraisal measures

The data in Figure 3 has been collected to appraise the performance of four asset management firms:

Figure 3: Performance Appraisal Data

	Fund 1	*Fund 2*	*Fund 3*	*Fund 4*	*Market Index*
Return	6.45%	8.96%	9.44%	5.82%	6%
Beta	0.88	1.02	1.36	0.80	1.00
Standard deviation	2.74%	4.54%	3.72%	2.64%	2.80%
Standard deviation of excess returns	5.6%	6.1%	12.5%	5.3%	N/A

The market index return and risk-free rate of return for the relevant period were 6% and 3%, respectively. **Calculate** and **rank** the funds using Jensen's alpha, the Treynor measure, the Sharpe ratio, the information ratio, and M^2.

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Answer:

Evaluation Tool	*Fund 1*	*Fund 2*	*Fund 3*	*Fund 4*
Jensen's Alpha	6.45 – 5.64 = 0.81%	8.96 – 6.06 = 2.90%	9.44 – 7.08 = 2.36%	5.82 – 5.40 = 0.42%
Rank	3	1	2	4
Treynor	$\frac{6.45-3}{0.88}=3.92$	$\frac{8.96-3}{1.02}=5.84$	$\frac{9.44-3}{1.36}=4.74$	$\frac{5.82-3}{0.80}=3.53$
Rank	3	1	2	4
Sharpe	$\frac{6.45-3}{2.74}=1.26$	$\frac{8.96-3}{4.54}=1.31$	$\frac{9.44-3}{3.72}=1.73$	$\frac{5.82-3}{2.64}=1.07$
Rank	3	2	1	4
Information Ratio	$\frac{6.45-6}{5.6}=0.08$	$\frac{8.96-6}{6.1}=0.49$	$\frac{9.44-6}{12.5}=0.28$	$\frac{5.82-6}{5.3}=-0.03$
Rank	3	1	2	4
M^2	3 + (1.26) × (2.8) = 6.53% – 6% =0.53%	3 + (1.31) × (2.8) = 6.67% – 6% =0.67%	3 + (1.73) × (2.8) = 7.84% – 6% 1.84%	3 + (1.07) × (2.8) = 6% – 6% =0
Rank	3	2	1	4

Note that Jensen's alpha and the Treynor measures give the same rankings, and the Sharpe and M^2 measures give the same rankings. However, when comparing the alpha/Treynor rankings to the Sharpe/M^2 measures, Funds 2 and 3 trade places.

Fund 2 has a much higher total risk (standard deviation) than Fund 3 but has a much lower beta. Relatively speaking, a smaller proportion of Fund 2's total risk relates to systematic risk, which is reflected in the low beta. Compared to Fund 3, it must have a bigger proportion of risk relating to non-systematic risk factors.

Hence, Fund 2 does better in the alpha/Treynor measures, as those measures only look at systematic risk (beta). It fares less well when it comes to the Sharpe/M^2 measures that look at total risk.

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Statistical Significance of Alpha Returns

LO 65.4: Describe the statistical significance of a performance measure using standard error and the t-statistic.

Alpha (α) plays a critical role in determining portfolio performance. A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark. The performance indicated by alpha, however, could be a result of luck and not skill. In order to assess a manager's ability to generate alpha, we conduct a *t*-test under the following hypotheses:

Null (H_0): True alpha is zero.

Alternative (H_A): True alpha is not zero.

$$t = \frac{\alpha - 0}{\sigma / \sqrt{N}}$$

where:
α = alpha estimate
σ = alpha estimate volatility
N = sample number of observations
standard error of alpha estimate = $\sigma / \sqrt{N}$

In order to compute the ***t*-statistic**, we will need to know the alpha estimate, the sample number of observations, and the alpha estimate of volatility. From the volatility and sample size estimates, we can compute the **standard error** of the alpha estimate, which is shown in the denominator of the *t*-statistic calculation.

At a 95% confidence level (5% significance level) we reject the null hypothesis if we estimate a *t*-value of 2 or larger. That is, the probability of observing such a large estimated alpha by chance is only 5%, assuming returns are normally distributed.

Professor's Note: Using a t-value of 2 is a general test of statistical significance. From the FRM Part I curriculum, we know that the actual t-value with a 95% confidence level given a large sample size is 1.96.

If we assume an excess (alpha) return of 0.09% and a standard error of the alpha of 0.093%, the *t*-statistic would be equal to 0.97 (t = 0.09% / 0.093%); therefore, we fail to reject H_0 and conclude that there is no evidence of superior (or inferior) performance.

Professor's Note: Using statistical inference when evaluating performance is extremely challenging in practice. By the time you are reasonably confident that a manager's returns are in fact due to skill, the manager may have moved elsewhere.

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Measuring Hedge Fund Performance

LO 65.5: Explain the difficulties in measuring the performance of hedge funds.

Long-short hedge funds are often used to complement an investor's well-diversified portfolio. For example, the investor might allocate funds to a passively managed index fund and an actively managed long-short hedge fund. The hedge fund is designed to provide positive alpha with zero beta to the investor's overall composite portfolio. The hedge fund creates **portable alpha** in the sense that the alpha does not depend on the performance of the broad market and can be ported to any existing portfolio. Because the long-short fund is market-neutral, the alpha may be generated outside the investor's desired asset class mix.

Unfortunately, hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).
- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

The latter problem necessitates the use of estimated prices for hedge fund holdings. The values of the hedge funds, therefore, are not transactions-based. The estimation process unduly smoothes the hedge fund "values," inducing serial correlation into any statistical examination of the data.

Performance Evaluation With Dynamic Risk Levels

LO 65.6: Explain how changes in portfolio risk levels can affect the use of the Sharpe ratio to measure performance.

The Sharpe ratio is useful when evaluating the portfolio performance of a passive investment strategy, where risk and return characteristics are relatively constant over time. However, the application of the Sharpe ratio is challenged when assessing the performance of active investment strategies, where risk and return characteristics are more dynamic. Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

Take for example a low-risk portfolio with an alpha return of 1% and a standard deviation of 3%. The manager implements this strategy for one-year, producing quarterly returns of –2%, 4%, –2%, and 4%. The Sharpe ratio for this portfolio is calculated as: 1% / 3% = 0.3333. If the market index has a Sharpe ratio of 0.3, we would conclude that this portfolio has superior risk-adjusted performance. In the following year, the portfolio manager decides to switch to a high-risk strategy. The alpha return and risk correspondingly increase to 5% and 15%, respectively. For the second year, quarterly returns were –10%, 20%, –10%, and 20%. The Sharpe ratio in this case is still 0.3333 (= 5% / 15%), which still indicates superior performance compared to the market index. However, if the Sharpe ratio is evaluated over the two-year time frame, considering both the low-risk and high-risk strategies, the measure will drop to 0.2727 since average excess return over both years was 3% with volatility of 11%. The lower Sharpe ratio now suggests underperformance relative to the market index.

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In this example, the Sharpe ratio was biased downward due to the perceived increase in risk in portfolio returns. In isolation, both the low-risk and high-risk strategies produced higher Sharpe ratios than the market index. However, when analyzed together, the Sharpe ratio suggests that the portfolio excess returns are inferior to the market. Therefore, it is important to consider changes in portfolio composition when using performance measures, as dynamic risk levels can lead to incorrect ranking conclusions.

Measuring Market Timing Ability

LO 65.7: Describe techniques to measure the market timing ability of fund managers with a regression and with a call option model.

Measuring Market Timing with Regression

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio. Using a market timing regression model, we can empirically test whether there is evidence of superior market timing skills exhibited by the portfolio manager. The regression equation used for this test is as follows:

$$R_P - R_F = \alpha + \beta_P(R_M - R_F) + M_P(R_M - R_F)D + \varepsilon_P$$

In this equation, *D* is a dummy variable that is assigned a value of 0 for down markets (i.e., when $R_M < R_F$) and 1 for up markets (i.e., when $R_M > R_F$). M_P is the difference between the up market and down market betas and will be positive for a successful market timer. In a bear market, beta is simply equal to β_P. In a bull market, beta is equal to $\beta_P + M_P$. Empirical evidence of mutual fund return data suggests that M_P is actual negative for most funds. Thus, researchers have concluded that fund managers exhibit little, if any, ability to correctly time the market.

Measuring Market Timing with a Call Option Model

Consider an investor who has 100% perfect market forecasting ability and holds a portfolio allocated either 100% to Treasury bills or 100% to the S&P 500 equity market index, depending on the forecast performance of the S&P 500 versus the Treasury bill return. The investor's portfolio will be:

100% invested in the S&P 500 if $E(R_M) > R_F$
100% invested in Treasury bills if $E(R_M) < R_F$

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If the investor has perfect forecasting ability, then his return performance will be as follows:

R_M if $R_M > R_F$
R_F if $R_M < R_F$

Now consider an investor who invests S_0 (the current value of the S&P 500) in Treasury bills and also owns a call option on the S&P 500 with exercise price equal to the current value of the index times $(1 + R_F)$, or $S_0(1+R_F)$. Note that the exercise price equals the value of the S&P 500 if it grows at a rate equal to the risk-free rate.

What are the return possibilities for this investor? To answer this question, note that if the S&P 500 holding period return exceeds the risk-free rate, then the ending value of the call option will be:

$$S_T - X = S_0(1+R_M) - S_0(1+R_F)$$

The investor also owns Treasury bills with face value equal to $S_0(1+R_F)$. Therefore, the face value (FV) of the Treasury bills will perfectly offset the exercise price of the call option. In the up-market scenario, the ending value of the calls plus bills portfolio equals:

$$S_T - X + FV = S_0(1+R_M) - S_0(1+R_F) + S_0(1+R_F) = S_0(1+R_M)$$

Therefore, the return performance on the calls plus bills portfolio will equal:

R_M if $R_M > R_F$

If the market rises by less than the risk-free rate, the call option has no value, but the risk-free asset will still return R_F. Therefore, the down-market scenario return for the calls plus bills portfolio is:

R_F if $R_M < R_F$

In summary, the returns to the calls plus bills portfolio are identical to the 100% perfect foresight returns. Therefore, the value or appropriate fee for perfect foresight should equal the price of the call option on the market index.

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Style Analysis

LO 65.8: Describe style analysis.

LO 65.9: Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision and the aggregate contribution.

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing). The importance of long-run asset allocation has been well established empirically. These results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

The steps for Sharpe's style analysis are as follows:

1. Run a regression of portfolio returns against an exhaustive and mutually exclusive set of asset class indices:

   $$R_P = b_{P1}R_{B1} + b_{P2}R_{B2} + \ldots + b_{Pn}R_{Bn} + e_P$$

   where:
   R_P = return on the managed portfolio
   R_{Bj} = return on passive benchmark asset class n
   b_{Pj} = sensitivity or exposure of Portfolio P return to passive asset class n return
   e_P = random error term

In Sharpe's style analysis, the slopes are constrained to be non-negative and to sum to 100%. In that manner, the slopes can be interpreted to be "effective" allocations of the portfolio across the asset classes.

2. Conduct a performance attribution (return attributable to asset allocation and to selection):
   - The percent of the performance attributable to asset allocation = R^2 (the coefficient of determination).
   - The percent of the performance attributable to selection = $1 - R^2$.

The **asset allocation attribution** equals the difference in returns attributable to active asset allocation decisions of the portfolio manager:

$$[b_1R_{B1} + b_2R_{B2} + \ldots + b_nR_{Bn}] - R_B$$

Notice if the slopes (estimated allocations) for the managed portfolio equal those within the benchmark (passive asset allocation), then the asset allocation attribution will be zero.

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The **selection attribution** equals the difference in returns attributable to superior individual security selection (correct selection of mispriced securities) and sector allocation (correct over and underweighting of sectors within asset classes):

$$R_P - [b_1R_{B1} + b_2R_{B2} + ...+ b_nR_{Bn}]$$

Notice if the manager has no superior selection ability, then portfolio returns earned within each asset class will equal the benchmark asset class returns: $R_{Pj} = R_{Bj}$, and the selection attribution will equal zero. Also, notice that the sum of the two attribution components (asset allocation plus selection) equals the total excess return performance: $R_P - R_B$.

3. Uncover the investment style of the portfolio manager: the regression slopes are used to infer the investment style of the manager. For example, assume the following results are derived:

$$R_P = 0.75R_{LCG} + 0.15R_{LCV} + 0.05R_{SCG} + 0.05R_{SCV}$$

where:
R_{LCG} = return on the large cap growth index
R_{LCV} = return on the large cap value index
R_{SCG} = return on the small cap growth index
R_{SCV} = return on the small cap value index

The regression results indicate that the manager is pursuing primarily a large cap growth investment style.

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Key Concepts

LO 65.1

The dollar-weighted rate of return is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

Time-weighted rate of return measures compound growth. It is the rate at which $1 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time.

LO 65.2

The Sharpe ratio uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk.

The Treynor measure is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

Jensen's alpha is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return.

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken to achieve a certain level of return above the benchmark.

LO 65.3

The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

LO 65.4

A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark.

LO 65.5

Hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).
- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

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LO 65.6

Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

LO 65.7

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio.

LO 65.8

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing).

LO 65.9

The importance of long-run asset allocation has been well established empirically. Historical results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

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Concept Checkers

Use the following data to answer Questions 1 and 2.

Assume you purchase a share of stock for $50 at time t = 0 and another share at $65 at time t = 1, and at the end of year 1 and year 2, the stock paid a $2.00 dividend. Also at the end of year 2, you sold both shares for $70 each.

1. The dollar-weighted rate of return on the investment is:
   A. 10.77%.
   B. 15.45%.
   C. 15.79%.
   D. 18.02%.

2. The time-weighted rate of return on the investment is:
   A. 18.04%.
   B. 18.27%.
   C. 20.13%.
   D. 21.83%.

3. The following information is available for funds ABC, RST, JKL, and XYZ:

Fund	*Annual Rate of Return*	*Beta*	*Volatility*
ABC	15%	1.25	20%
RST	18%	1.00	25%
JKL	25%	1.20	15%
XYZ	11%	1.36	9%

   The average risk-free rate was 5%. Rank the funds from best to worst according to their Treynor measure.
   A. JKL, RST, ABC, XYZ.
   B. JKL, RST, XYZ, ABC.
   C. RST, JKL, ABC, XYZ.
   D. XYZ, ABC, RST, JKL.

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Use the following information to answer Question 4.

The following data has been collected to appraise funds A, B, C, and D:

	Fund A	*Fund B*	*Fund C*	*Fund D*	*Market Index*
Return	8.25%	7.21%	9.44%	10.12%	8.60%
Beta	0.91	0.84	1.02	1.34	1.00
Standard deviation	3.24%	3.88%	3.66%	3.28%	3.55%

The risk-free rate of return for the relevant period was 4%.

4. Calculate and rank the funds from best to worst using Jensen's alpha.
   A. B, D, A, C.
   B. A, C, D, B.
   C. C, A, D, B.
   D. C, D, A, B.

5. Sharpe's style analysis, used to evaluate an active portfolio manager's performance, measures performance relative to:
   A. a passive benchmark of the same style.
   B. broad-based market indices.
   C. the performance of an equity index fund.
   D. an average of similar actively managed investment funds.

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Concept Checker Answers

1. **D** One way to do this problem is to set up the cash flows so that the PV of inflows = PV of outflows and then to plug in each of the multiple choices.

   $50 + 65 / (1 + \text{IRR}) = 2 / (1 + \text{IRR}) + 144 / (1 + \text{IRR})^2 \rightarrow \text{IRR} = 18.02\%$

   Alternatively, on your financial calculator, solve for IRR: $-50 - \frac{65-2}{1+\text{IRR}} + \frac{2(70+2)}{(1+\text{IRR})^2} = 0$

Calculating Dollar-Weighted Return With the TI Business Analyst II Plus®		
Key Strokes	Explanation	Display
[CF] [2nd] [CLR WORK]	Clear CF Memory Registers	CF0 = 0.00000
50 [+/–] [ENTER]	Initial cash inflow	CF0 = –50.00000
[↓] 63 [+/–][ENTER]	Period 1 cash inflow	C01 = –63.00000
[↓] [↓] 144 [ENTER]	Period 2 cash outflow	C02 = 144.00000
[IRR] [CPT]	Calculate IRR	IRR = 18.02210

2. **D** $\text{HPR}_1 = (65 + 2) / 50 - 1 = 34\%$, $\text{HPR}_2 = (140 + 4) / 130 - 1 = 10.77\%$

   time-weighted return = $[(1.34)(1.1077)]^{0.5} - 1 = 21.83\%$.

3. **A** Treynor measures:

$$T_{ABC} = \frac{0.15 - 0.05}{1.25} = 0.08 = 8$$

$$T_{RST} = \frac{0.18 - 0.05}{1.00} = 0.13 = 13$$

$$T_{JKL} = \frac{0.25 - 0.05}{1.20} = 0.1667 = 16.7$$

$$T_{XYZ} = \frac{0.11 - 0.05}{1.36} = 0.0441 = 4.4$$

The following table summarizes the results:

Fund	*Treynor Measure*	*Rank*
ABC	8.00%	3
RST	13.00%	2
JKL	16.67%	1
XYZ	4.41%	4

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4. **C** CAPM Returns:

R_A = 4 + 0.91(8.6 – 4) = 8.19%
R_B = 4 + 0.84(8.6 – 4) = 7.86%
R_C = 4 + 1.02(8.6 – 4) = 8.69%
R_D = 4 + 1.34(8.6 – 4) = 10.16%

	Fund A	*Fund B*	*Fund C*	*Fund D*
Alpha	8.25% – 8.19% = +0.06	7.21% – 7.86% = –0.65%	9.44% – 8.69% = +0.75%	10.12% – 10.16% = –0.04%
Ranking	2	4	1	3

5. **A** Sharpe's style analysis measures performance relative to a passive benchmark of the same style.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Illiquid Assets

Topic 66

Exam Focus

This topic examines illiquid asset market characteristics and the relationship between illiquidity and market imperfections. Reported return biases are discussed as well as the illiquidity risk premium within and across asset classes. For the exam, understand that all markets, even highly liquid markets such as commercial paper, can be illiquid at some points in time. Also, know the three biases that impact reported returns of illiquid asset classes (survivorship bias, sample selection bias, and infrequent sampling). Finally, understand the factors that influence the decision to include illiquid asset classes in a portfolio.

Illiquid Asset Markets

LO 66.1: Evaluate the characteristics of illiquid markets.

There are several characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.
2. Markets for illiquid assets are large.
3. Illiquid assets comprise the bulk of most investors' portfolios.
4. Liquidity dries up even in liquid asset markets.

Most Asset Classes Are Illiquid

All markets, even large-cap equity markets, are somewhat illiquid. It is clear, however, that some assets (e.g., real estate) are less liquid than others (e.g., public equities). Illiquid assets trade infrequently, in small amounts, and generally exhibit low turnover. For example, there are mere seconds between transactions in public equity markets with an annualized turnover rate greater than 100%. In contrast, over-the-counter (OTC) equities typically trade within a day, but sometimes a week or more may pass between trades, with annualized turnover of 25% to 35%. Corporate bonds trade daily, and municipal bonds typically trade semiannually. At the far end of the liquidity spectrum is institutional infrastructure with an average investment commitment of 50 to 60 years (up to 99 years), and art, with 40 to 70 years between transactions. There is negligible turnover in infrastructure. Turnover in residential real estate is about 5% per year, while turnover in institutional real estate is approximately 7%. Time between real estate transactions can range from months to decades.

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Markets for Illiquid Assets Are Large

The size of the U.S. residential mortgage market was $16 trillion in 2012. The institutional real estate market was measured at $9 trillion. In contrast, the market capitalization of the NYSE and Nasdaq combined was approximately $17 trillion. The total wealth held in illiquid assets exceeds the total wealth in traditional, liquid stock, and bond markets.

Investor Holdings of Illiquid Assets

The home is often an individual's most valuable asset. As a result, illiquid assets represent approximately 90% of total wealth, not counting human capital, the largest and least liquid asset for many individual investors. High net worth individuals in the United States even typically allocate 10% of portfolios to fine art and jewelry, known as treasure assets. High net worth individuals in foreign countries hold an average of 20% in treasure assets. Institutional investors have also increased allocations to illiquid assets over the last 20 years. University endowments have increased allocations of illiquid assets to approximately 25%, up from 5% in the early 1990s. Pension funds have increased allocations to approximately 20%, up from 5% in 1995. In general, investors hold sizeable amounts of illiquid assets.

Liquidity Can Dry Up

In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. For example, money markets froze (i.e., repurchase agreement and commercial paper markets) during the crisis as investors were unwilling to trade at any price. Residential and commercial mortgage-backed securities markets, structured credit markets, and the auction rate securities market, a market for floating rate municipal bonds, also became illiquid during the crisis. The auction rate securities market is still frozen, more than six years later. Major liquidity crises have occurred at least once every 10 years across the globe, in conjunction with downturns and financial distress.

Market Imperfections

LO 66.2: Examine the relationship between market imperfections and illiquidity.

Many economic theories assume that markets are perfect. This means that market participants are rational and pursue utility maximization, that there are no transactions costs, regulation or taxes, that assets are perfectly divisible, that there is perfect competition in markets, and that all market participants receive information simultaneously. The reality, though, is that markets are imperfect.

Imperfections that encourage illiquidity include:

- **Market participation costs.** There are costs associated with entering markets, including the time, money, and energy required to understand a new market. In many illiquid markets, only certain types of investors have the expertise, capital, and experience to participate. This is called a **clientele effect**. There will be less liquidity in markets that are suited to a limited number of investors and/or where there are barriers to entry in terms of required experience, capital, or expertise.

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- **Transaction costs.** Transaction costs include taxes and commissions. For many illiquid assets, like private equity, there are additional costs, including costs associated with performing due diligence. Investors must pay attorneys, accountants, and investment bankers. These costs can impede investment.

When acknowledging the existence of transaction costs (i.e., acknowledging that markets are imperfect), some academic studies assume that as long as an investor can pay the transaction costs (and sometimes these costs are large), then any investor can transact (i.e., any asset can be liquid if one can pay the transaction cost). However, this is not always true. For example, there are:

- **Difficulties finding a counterparty (i.e., search frictions).** For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase an office tower or a skyscraper in a city like New York. No matter how high the transaction cost, it may take weeks, months, or years to transact in some situations.
- **Asymmetric information.** Some investors have more information than others. If an investor fears that the counterparty knows more than he does, he will be less willing to trade, which increasing illiquidity. When asymmetric information is extreme, people assume all products are lemons. Because no one wants to buy a lemon, markets break down. Often liquidity freezes are the result of asymmetric information. Because investors are looking for non-predatory counterparties who are not seeking to take advantage of asymmetric information, information itself can be a form of search friction.
- **Price impacts.** Large trades can move markets, which, in turn, can result in liquidity issues for the asset or asset class.
- **Funding constraints.** Many illiquid assets are financed largely with debt. For example, even at the individual level, housing purchases are highly leveraged. As a result, if access to credit is compromised, investors cannot transact.

Illiquid Asset Return Biases

LO 66.3: Assess the impact of biases on reported returns for illiquid assets.

In general, investors should be skeptical of reported returns in illiquid asset markets. The reason is that reported returns are generally overstated. There are reporting biases that result in inflated returns. Three main biases that impact returns of illiquid assets are:

- Survivorship bias.
- Selection bias.
- Infrequent trading.

Survivorship Bias

There are no requirements for certain types of funds (e.g., private equity, hedge funds, buyout funds, and so on) to report returns to database providers. As such, poorly performing funds have a tendency to stop reporting. Additionally, funds may never begin reporting because returns are not high enough to appeal to investors. This results in **reporting biases**. In addition, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called **survivorship bias**. Non-surviving funds

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have below average returns and surviving funds have above average returns, but it is the surviving fund returns that are reported. Studies show mutual fund returns are 1% to 2% lower than reported and returns may be as much as 4% lower for illiquid asset markets. While the solution to survivorship bias seems obvious (to observe the entire universe of funds), it is impossible to do in illiquid asset markets.

Sample Selection Bias

Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. Often, a seller will wait until property values recover before selling. These higher selling prices are then used to calculate returns. This results in **sample selection bias**.

The problem with selection bias is especially prevalent in private equity markets. Buyout funds take companies public when stock prices are high. Venture capitalists sell companies when values are high. Distressed companies are often not liquidated and left as shell companies (these are sometimes called zombie companies). It is difficult to tell, based on old data without any recent transactions, if a company is alive or whether it is a zombie.

Impacts of sample selection bias include:

- Higher reported alphas relative to true alphas because only high prices are recorded. For example, one study estimates an alpha of more than 90% for venture capital log returns. However, alpha falls to –7% after correcting for sample selection bias. Another study estimates returns are decreased 2% to 5% per month if you correct for the bias.
- Lower reported betas than true betas because there are fewer (only high) prices recorded, flattening the security market line (SML). The effect is smaller for real estate returns because volatility is lower than in private equity and studies often include downturns such as what happened in real estate in the early 1990s and the early 2000s.
- Lower reported variance of returns than the true variance of returns because only high returns are counted (i.e., underestimated risk).

In sum, sample selection bias results in overestimated expected returns and underestimated risk as measured by beta and the standard deviation of returns (i.e., volatility).

Infrequent Trading

Illiquid assets, by definition, trade infrequently. **Infrequent trading** results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets. Returns for these infrequently traded assets are smoothed. For example, if one compares quarterly returns to the daily returns of the same asset, quarterly returns will appear (and actually be) less volatile. Prices will often be higher or lower in a given investment horizon, than it appears when examining quarterly returns. The computed standard deviation of returns often will be lower when examining quarterly returns compared to daily returns. Also, correlations with other asset classes (e.g., liquid assets such as large-cap stocks) will be artificially low because return volatility is muted by infrequent trades.

It is possible to unsmooth or de-smooth returns using **filtering algorithms**. Filtering algorithms generally remove noise from signals. However, unsmoothing adds noise back to

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reported returns to uncover the true, noisier returns. Unsmoothing returns affects risk and return estimates, and could have a dramatic effect on returns. For example, reported real estate returns during the 1990s downturn were –5.3%. The corresponding unsmoothed returns were –22.6%. The National Council of Real Estate Investment Fiduciaries (NCREIF) returns reached –8.3% in December 2008. Unsmoothed returns during the same quarter were –36.3%. The standard deviation of the raw returns was 2.25% during the same quarter compared to 6.26% for unsmoothed returns. For comparison, stock return volatility was approximately 7.5% per quarter. Correlations between the S&P 500 Index and NCREIF returns increased from 9.2% to 15.8% when returns were unsmoothed.

Illiquidity Risk Premiums

LO 66.4: Compare illiquidity risk premiums across and within asset categories.

Illiquidity Risk Premiums Across Asset Classes

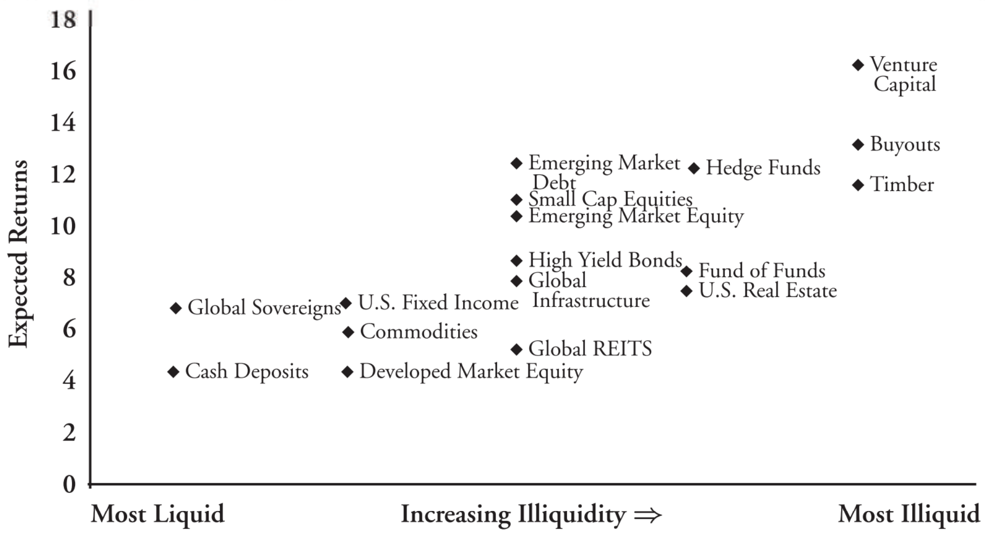
As part of the analysis in Antti Ilmanen's 2011 book *Expected Returns*[1], we can relate liquidity to expected returns as shown in Figure 1. Note, however, that we cannot completely pigeonhole asset classes based on illiquidity (e.g., some private equity funds are more liquid than some hedge funds or infrastructure investments). Also note that, in this analysis, returns are computed over the period 1990 to 2009 and the illiquidity estimates are just estimates (i.e., they represent Ilmanen's opinions). Ilmanen's work does imply a positive relationship between the illiquidity of an asset class and its expected return. Venture capital is considered the least liquid and has the highest expected return, between 16% and 17%. Buyout funds and timber are also illiquid but command lower expected returns, approximately 13% and close to 12%, respectively. Hedge funds are more liquid and are expected to earn a little more than 12%. Real estate is on par with hedge funds in terms of liquidity but commands a lower return of nearly 8%. Equities are much more liquid and earned a bit more than 4% over the period. Cash is the most liquid and it too earned a little over 4% during the period.

1 Ilmanen, A. (2011). *Expected Returns: An Investor's Guide to Harvesting Market Rewards*. Chichester, West Sussex, U.K.: Wiley.

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Figure 1: Liquidity vs. Expected Returns



It is the conventional view that there is a premium for illiquidity. However, this may not be true. First, there are illiquidity biases. As discussed in the previous LO, reported returns of illiquid assets are too high (i.e., overstated if using raw, unsmoothed data) and risk and correlation estimates are too low.

Second, illiquid asset classes such as private equity, buyout funds, and physical assets like timber contain significant risks beyond liquidity risk. After adjusting for these risks, illiquid asset classes are much less attractive. According to one study, after adjusting for risk, most investors are better off investing in the S&P 500 than in a portfolio of private equity.

Third, there is no "market index" for illiquid assets. Private equity, hedge fund, and real estate indices are not investable, so no investor is actually earning the index return. For example, the NCREIF includes thousands of properties. Because individuals do not typically own thousands of properties, they are much more subject to idiosyncratic risks and are less diversified within the asset class.

Fourth, you must rely on manager skill in illiquid asset classes. There is no way, as there is with tradeable, cheap bond and equity index funds, to separate factor risk (i.e., systematic risk) from the talents of fund managers. As noted, there is no way to earn index returns. If an investor cannot earn index returns in illiquid asset class markets, he has no way of separating passive returns from alpha generated by active managers.

These factors imply that it may not be possible to generate substantial illiquidity risk premiums across illiquid asset classes. However, there is evidence of large illiquidity risk premiums within asset classes.

Illiquidity Risk Premiums Within Asset Classes

Less liquid assets generally have higher returns than more liquid assets, within asset classes. Currently, there is no formal theory about why illiquidity risk premiums exist within asset

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classes but not between. It might be that investors simply overpay for illiquid asset classes, chasing the illusion of higher returns. It may also be that firms do not manage portfolios as a cohesive whole, but instead put asset classes in different silos. Mispricing (i.e., the lack of a premium across classes) may be due to slow-moving capital across classes, limits to arbitrage, and institutional constraints (e.g., the fixed-income desk doesn't talk to the equity traders, and so on).

Illiquidity Effects in U.S. Treasury Markets

On-the-run (i.e., newly issued) Treasury bills (T-bills) are more liquid and have lower yields than off-the-run (seasoned) T-bills. The difference is called the on-the-run/off-the-run bond spread. During the 2007–2009 financial crisis, same maturity T-bonds and T-notes traded with different yields. While prices should have been the same, T-bond prices were more than 5% lower than T-note prices. Given that the U.S. Treasury market is one of the largest and most liquid in the world, it is surprising to observe large illiquidity effects.

Illiquidity Effects in Corporate Bond Markets

Larger bid-ask spreads and infrequent trading led to higher yields in corporate bond markets. Studies indicate that illiquidity risk explains 7% of the variation in investment grade bond yields and 22% of the variation in junk bond yields. Also, as bid-ask spreads increase, yield spreads increase by more than double the amount (e.g., a one-basis point increase in the bid-ask spread results in a more than two-basis point increase in the yield spread).

Illiquidity Effects in Equity Markets

There are several variables related to illiquidity that are shown to impact equity returns. Studies indicate that less liquid stocks earn higher returns than more liquid stocks. Illiquidity factors that impact equity returns are:

- Bid-ask spreads.
- Volume.
- Turnover.
- Volume measured by whether the trade was initiated by buyers or sellers.
- Ratio of absolute returns to dollar volume, called the "Amihud measure."
- Price impact of large trades.
- Informed trading measures (i.e., adverse selection).
- Quote size.
- Quote depth.
- Frequency of trades.
- Number of "zero" returns (in liquid markets returns are usually not zero).
- Return autocorrelations (which are a measure of stale prices).

All of these factors are characteristics of illiquidity that are unique to each stock. There are also illiquidity risk betas that are covariances of stock returns with illiquidity factors. Researchers estimate illiquidity risk premiums at 1% to 8% depending on the illiquidity measure used. Research also indicates that risk premiums have declined, although studies find a 1% risk premium for listed equities compared to a 20% risk premium for OTC stocks.

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Secondary Markets for Private Equity and Hedge Funds

Private equity funds trade companies with each other, providing needed liquidity. In 2005, these secondary buyouts represented about 15% of all private-equity buyout deals. This does allow funds to get out of specific deals, may give limited partners (LPs) some cash in the process, and may allow LPs to better understand the values of portfolio companies. However, secondary buyouts do not allow limited partners to get out of the private equity fund itself.

LPs can exit private equity funds in secondary markets. However, these markets are immature, small, and more opaque. Firms participating in these markets on the buy side were called vultures in the 1990s. Buyers took advantage of distressed sellers, getting discounts of 30% to 50%. Discounts fell below 20% in the early 2000s, but shot up again during the 2007–2009 financial crisis.

Harvard University saw its endowment fall by more than $8 billion, or 22%, between July 1, 2008, and October 31, 2008. Harvard relies on the endowment for some of its operating funds. Endowment fund managers attempted to sell stakes in private equity to free up cash for operations and faced discounts of 50%.

Because hedge fund investors can typically redeem their investments at predetermined dates, discounts on secondary market transactions are much smaller than in private equity investments. During the recent financial crisis, hedge fund discounts were 6% to 8% on average. Some funds traded at a premium, even during the crisis, due to strong demand (i.e., the funds were closed to new investors). Large asset owners like sovereign funds and pension funds can supply liquidity in hedge fund and private equity markets, buying stakes at reduced prices and harvesting illiquidity risk premiums.

In sum, there are four ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is **passive allocation to illiquid asset classes**.

2. Choosing more illiquid assets within an asset class. This means engaging in **liquidity security selection**.

3. Acting as a **market maker** for individual securities. For example, Dimensional Funds Advisors (DFA) is a liquidity provider that buys stock at a discount from those wanting to sell quickly and sells small-cap stocks at a premium to investors demanding shares. The firm avoids adverse selection problems by choosing counterparties who fully disclose information about stocks. The firm is trustworthy in its dealings and does not manipulate prices or engage in front running. Sovereign wealth funds, large pension funds, and other large asset owners can also act as market makers, providing liquidity while buying at discounts and selling at premiums.

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4. Engaging in **dynamic factor strategies** at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Investors rebalance to take advantage of the liquidity differences as less liquid assets become more liquid. Rebalancing the portfolio is the simplest way to provide liquidity. As long as buyers buy when others want to sell and sell when others want to buy, rebalancing is countercyclical. Of the four ways investors can harvest the illiquidity premium, this is the easiest to implement and can have the greatest effect on portfolio returns.

Portfolio Allocation to Illiquid Assets

LO 66.5: Evaluate portfolio choice decisions on the inclusion of illiquid assets.

In determining the portfolio allocation to illiquid asset classes, or any asset class for that matter, investors must consider their personal circumstances. The illiquid asset allocation decision is influenced by different investment horizons, the lack of tradeable indices, the need to hire talented active portfolio managers, and the need to monitor those managers. Portfolio choice models that include illiquid assets must consider two important aspects of illiquidity that impact investors:

1. Long time horizons between trades (i.e., infrequent trading).

2. Large transaction costs.

Asset Allocation to Illiquid Asset Classes with Transaction Costs

The primary issue with asset allocation models that include transaction costs is that they assume an asset will always trade if the counterparty pays the transaction cost. However, this is not true in private equity, infrastructure, real estate, and timber markets. It is not (or may not) be possible to find a buyer in a short period of time. Counterparties, if identified, must perform due diligence, which takes time. In some cases, the counterparty, upon completion of due diligence, chooses not to buy the asset. In periods of stress, even liquid asset classes face liquidity freezes and it becomes impossible to find buyers at any price.

Asset Allocation to Illiquid Asset Classes with Infrequent Trading

As anyone trying to sell in a period of illiquidity knows, one cannot "eat" illiquid assets. Consider the example of Harvard University, briefly described earlier. The only way the university could generate cash for operations in a period of significant losses and illiquidity across what some would consider some of the most liquid assets (i.e., commercial paper and repurchase agreements), Harvard would have had to sell at huge discounts. Only liquid assets can be consumed. As a result, illiquidity has a major effect on investors' portfolio choices. Illiquidity causes the following with respect to portfolio choice:

- **Reduces optimal holdings**. The less frequently a liquidity event is expected to occur, the lower the allocation to the illiquid asset class.
- Rebalancing illiquid assets (i.e., when there is infrequent trading in the asset class) causes allocations to **vary significantly**. The investor must wait until the liquidity event arrives. As such, the allocation prior to a liquidity event (or during nonrebalancing periods) can vary from too high to too low relative to the optimal allocation.

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- Investors cannot hedge against declining values when an asset cannot be traded. As a result, **illiquid asset investors must consume less** than liquid asset investors to offset the risk.
- **There are no illiquidity "arbitrages."** To construct an arbitrage, an asset must be continuously traded. Illiquid assets are not continuously traded.
- Due to infrequent trading, illiquid asset investors must **demand an illiquidity risk premium**. The more frequently the asset is traded, the lower the premium. For example, one study indicates that private equity investments generate returns 6% higher than public markets to compensate investors for illiquidity.

The inclusion of illiquid assets in a portfolio is not as simple or desirable as it might seem. The following points should be considered:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of the manager. It is difficult to monitor external managers (e.g., private equity managers).

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no "market" portfolio of illiquid assets. Recall the example of the NCREIF versus the individual investor. It is not possible for most investors to hold thousands of properties, and small numbers of properties can lead to undiversified, property specific risks (but also returns, making illiquid assets compelling to investors). Illiquid assets are compelling because:
    - Illiquid asset markets are less efficient than stock and bond markets.
    - There are large information asymmetries in illiquid asset markets.
    - High transaction costs keep many investors out of the market.
    - Management skill is crucial and alpha opportunities are widely dispersed.

    All of these factors suggest there are great opportunities for the skilled investor to profit from investments in illiquid assets. Investors must have the skills and resources to find, evaluate, and monitor illiquid asset opportunities. Endowments like Harvard, Yale, and Stanford have the skills and resources. Unskilled investors, even those endowments at less sophisticated, skilled, and connected schools, can lose big in illiquid asset markets.

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Key Concepts

LO 66.1

There are four main characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.
2. Markets for illiquid assets are large.
3. Illiquid assets comprise the bulk of most investors' portfolios.
4. Liquidity dries up even in liquid asset markets.

LO 66.2

Market imperfections encourage illiquidity in asset markets. Specifically, market participation costs (i.e., clientele effects) and transaction costs give rise to illiquidity. Some academic models assume that all assets can be traded if one will pay the required (sometimes very high) transaction cost. However, this is not necessarily true in illiquid asset markets. There are search frictions (i.e., difficulties finding a counterparty and information asymmetries), price impacts, and funding constraints that may prevent trades from occurring, no matter how high the transaction cost.

LO 66.3

In general, investors should be skeptical of reported returns in illiquid asset markets as they are generally overstated. There are reporting biases that result in artificially inflated returns. The three main biases that impact reported illiquid asset returns are:

1. Survivorship bias: Poor performing funds often quit reporting results. Also, many poor performing funds ultimately fail. Finally, some poor performing funds never begin reporting returns because performance is weak. All of these factors lead to survivorship bias. Survivorship bias leads to an overstatement of stated returns relative to true returns.
2. Selection bias: Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. These higher selling prices are used to calculate returns. This results in sample selection bias, which again leads to overstated returns.
3. Infrequent trading: Illiquid assets, by definition, trade infrequently. Infrequent trading results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets.

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LO 66.4

There is little evidence that there are large illiquidity risk premiums across asset classes. However, there are large illiquidity risk premiums within asset classes.

There are four primary ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is passive allocation to illiquid asset classes.

2. Choosing more illiquid assets within an asset class. This means engaging in liquidity security selection.

3. Acting as a market maker for individual securities.

4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

LO 66.5

There are several points to consider when deciding to allocate portfolio resources to illiquid assets:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of portfolio managers. It is difficult to monitor external managers.

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no “market” portfolio of illiquid assets. Illiquid assets are compelling because illiquid asset markets are less efficient than stock and bond markets, there are large information asymmetries in illiquid asset markets, high transaction costs keep many investors out of the market, management skill is crucial, and alpha opportunities are widely dispersed.

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Concept Checkers

1. Global liquidity crises generally occur because:
   A. governments choose not to engage in monetary policy actions to stimulate economies.
   B. financial distress causes markets to freeze.
   C. markets for illiquid assets shrink, causing liquidity issues to infect traditional asset classes.
   D. transaction costs increase as developing economies get stronger.

2. When an investor has difficulty finding a counterparty for a complicated credit product like a structured debt instrument, this is known as:
   A. market participation costs.
   B. agency costs.
   C. search frictions.
   D. selection bias.

3. Blue Sky Funds, a private equity fund, has suffered low returns for the last five years. As a result, the find has decided to quit reporting returns. The fund did report returns each year for the last 10 years when performance was strong. This problem of reporting leads to:
   A. survivorship bias.
   B. sample selection bias.
   C. infrequent trading bias.
   D. attrition bias.

4. Which of the following variables is not an illiquidity factor that affects equity returns?
   A. Measures of adverse selection.
   B. The number of recorded positive returns.
   C. Turnover.
   D. Volume.

5. Rick Faircloth, a general partner and portfolio manager with Faircloth Funds, is considering ways in which his company can profit from illiquidity risk premiums. He has studied several alternative methods for harvesting illiquidity risk premiums. Which of the following strategies might Faircloth implement that will likely have the greatest effect on portfolio returns?
   A. Acting as a market maker for individual securities.
   B. Choosing the most illiquid assets within an asset class, even if the asset class is generally considered to be liquid.
   C. Allocating a portion of a portfolio to illiquid asset classes.
   D. Using dynamic factor strategies at the aggregate portfolio level.

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Concept Checker Answers

1. **B** In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. Major liquidity crises have occurred at least once every ten years across the globe, in conjunction with downturns and financial distress.

2. **C** Difficulties finding a counterparty are called search frictions. For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase multimillion dollar office towers in major metropolitan areas. No matter how high the transaction costs, it may take weeks, months, or years to transact in some situations. Asymmetric information can also be a type of search friction as investors search for non-predatory counterparties with which to transact.

3. **A** There are no requirements for certain types of funds, like private equity funds, to report returns. As such, poorly performing funds have a tendency to stop reporting. Additionally, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called survivorship bias.

4. **B** There are several variables related to illiquidity that are shown to impact equity returns. They are bid-ask spreads, volume, turnover, volume measured by whether the trade was initiated by buyers or sellers, the ratio of absolute returns to dollar volume, the price impact of large trades, informed trading measures (i.e., adverse selection), quote size and depth, the frequency of trades, the number of zero returns, and return autocorrelations. It is not the number of recorded positive returns, but the number of recorded zero returns, that are relevant.

5. **D** There are four primary ways that investors can harvest illiquidity premiums:

    1. Allocating a portion of the portfolio to illiquid asset classes like real estate (i.e., passive allocation to illiquid asset classes).

    2. Choosing more illiquid assets within an asset class (i.e., liquidity security selection).

    3. Acting as a market maker for individual securities.

    4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity risk premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Hedge Funds

Topic 67

Exam Focus

The topic examines two decades of hedge fund performance. Significant events that shaped the hedge fund industry are discussed, including the growth of institutional investments. Different hedge fund strategies are explained, along with the continuing growth of assets under management. Performance is analyzed to see if the rewards justify the risks, and performance is compared with the broad equity markets. The performance of top fund managers is also compared to the performance across the hedge fund industry.

Characteristics of Hedge Funds

LO 67.1: Describe the characteristics of hedge funds and the hedge fund industry, and compare hedge funds with mutual funds.

There are important distinctions between hedge funds and mutual funds. Hedge funds are private, much less regulated investment vehicles, not available to the general public. On the other hand, mutual funds are more structured and regulated. Hedge funds are highly leveraged, and managers obtain profits from both long and short positions. Hedge fund managers tend to take large bets based on perceived relative price discrepancies of assets.

Privacy is a hallmark of hedge funds. There is little transparency in the hedge fund industry because managers do not want their methods copied. A hedge fund charges a fixed management fee plus a healthy share of new profits from the fund, generally around 10–20%.

Evolution of the Hedge Fund Industry

LO 67.2: Explain biases which are commonly found in databases of hedge funds.

LO 67.3: Explain the evolution of the hedge fund industry and describe landmark events which precipitated major changes in the development of the industry.

LO 67.4: Evaluate the role of investors in shaping the hedge fund industry.

Historical data on hedge fund performance was difficult to obtain prior to the early 1990s. In early 1994, dramatic losses triggered by a Federal Reserve change in interest rate policy had a large impact on hedge fund performance reporting. This prompted the development of hedge fund databases so that participants could better obtain and analyze hedge fund performance.

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Assets under management have increased ten times from 1997 to 2010 as the number of funds has quadrupled. There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is **selection bias**, also known as **self-reporting bias**, contained in hedge fund databases.

There is evidence that suggests that selection bias in large hedge fund databases is actually small. The average return of funds-of-hedge funds (FOHF), comprised of managers who theoretically invest across all hedge funds, not just funds reported to commercial databases, is highly correlated to the average return of hedge funds in commercial databases.

However, there are still concerns about possible measurement errors and various biases in reported hedge fund returns. The consensus is that hedge fund index returns became increasingly reliable beginning in 1996. Prior to 1996, looking at the period from 1987 to 1996, 27 large hedge funds substantially outperformed the S&P 500 index. The outperformance is high, which is more than enough to account for any measurement biases.

The collapse of Long-Term Capital Management (LTCM) in 1998 was a watershed event in the hedge fund industry. It was a reminder that higher returns are accompanied by higher risk. The LTCM collapse had a much greater effect on hedge fund performance compared to equity performance.

The time period of 2000 to 2001 brought the dot-com bubble collapse. During this period, the hedge fund industry experienced a 20% net asset inflow and there was a major shift in the hedge fund industry structure. Hedge funds outperformed the S&P 500 with half of the S&P 500 standard deviation. As a result, institutional investors poured money into hedge funds.

From 1999 to 2007, hedge funds' assets under management went from $197 billion to $1.39 trillion. Investors in hedge funds thus shifted from exclusively private wealth to institutions, including foundations, endowments, pension funds, and insurance companies. Evidence suggests that these institutional investors were rewarded from 2002 to 2010 with high returns, due in large part to bearing credit and emerging market risks.

Alpha-Beta Separation

LO 67.5: Explain the relationship between risk and alpha in hedge funds.

Alpha is a risk-adjusted measure of return often used to assess the performance of active managers. It is the return in excess of the compensation for risk. It is important to identify how much of a strategy's return results from risk (i.e., beta) and how much results from active management (i.e., alpha). This is known as **distinguishing alpha and beta**. A manager who uses statistical techniques, quantitative tools, and benchmarking to discern whether high returns are the result of the superior performance of an active manager or a function of bearing high levels of systematic risk is attempting to distinguish alpha from beta.

A hedge fund may attempt to independently manage alpha and beta. The firm may manage beta exposure while separately managing the portfolio's alpha. This is known as **separating alpha and beta**. Managers can use investment tools to pursue alpha while sustaining a target

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beta for the portfolio. Managers typically seek to limit beta while trying to optimize alpha. Derivatives are often used to minimize or eliminate undesired systematic risk.

For example, assume a manager's benchmark is the S&P 500. He would like to pursue opportunities that increase alpha, but the result is beta exposure different from the benchmark. He can use futures contracts to hedge all systematic risks other than exposure to the S&P 500 such that the portfolio's beta relative to the S&P 500 is 1.0. He does this while simultaneously pursuing an alpha optimizing strategy. In this way, he is independently managing, or separating, alpha from beta.

Hedge Fund Strategies

LO 67.6: Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy.

Managed Futures and Global Macro

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. Systematic trading programs are used which rely on historical pricing data and market trends. A high degree of leverage is employed because futures contracts are used. With managed futures, there is no net long or net short bias.

Many managed futures funds are market timing funds, which switch between stocks and Treasuries. When both short and long positions are considered, the payoff function of this strategy is similar to a lookback straddle, which is a combination of a lookback call option and a lookback put option. The lookback call option gives the owner the right to purchase the underlying instrument at the lower price during the call option's life, while the lookback put option gives the owner the right to sell the underlying instrument at the highest price during the put option's life.

Global macro fund managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices. They are dynamic asset allocators, betting on various risk factors over time.

Both managed futures and global macro funds have *trend following* behavior (i.e., directional styles). Global macro funds do better during extreme moves in the currency markets. Both of these strategies are essentially *asset allocation* strategies, since the managers take opportunistic bets in different markets. They also both have a low return correlation to equities.

Merger/Risk Arbitrage and Distressed Securities

Merger (or risk) arbitrage strategies try to capture spreads in merger/acquisition transactions involving public companies, following public announcement of a transaction. The primary risk is **deal risk**, or the risk that the deal will fail to close.

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Examining merger arbitrage returns, the largest negative monthly returns in this strategy are after the S&P 500 index has had a large negative return. This equates to being long deal risk. The logic is that when the market has a large decline, mergers have a greater tendency to be called off.

Distressed hedge funds is another event-driven hedge fund style. This strategy invests across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a long bias. With this strategy, hedge fund managers try to profit from an issuer's ability to improve its operation, or come out of a bankruptcy successfully.

A key feature of the strategy is long exposure to credit risk of corporations with low credit ratings. A good proxy for these types of returns is publicly traded high-yield bonds since the correlation between the DJCS Distress index and high-yield bonds is 0.55.

In sum, both of these event-driven strategies exhibit nonlinear return characteristics, since tail risk appears under extreme market conditions. With merger arbitrage, the tail risk is a large drop in equity investments. With distressed hedge funds, the tail risk is a big move in short-term rates. Unlike trend following strategies, event-driven funds are hurt by extreme market movements.

Fixed Income Arbitrage

Fixed income arbitrage funds attempt to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. The fund managers try to limit volatility by hedging exposure to interest rate risk. An example of this strategy is leveraging long/short positions in fixed income securities that are related—mathematically or economically.

The sectors traded under fixed income arbitrage include:

- Credit yield curve relative value trading of swaps, government securities, and futures.
- Volatility trading using options.
- Mortgage-backed securities arbitrage.

A **swap spread trade** is a bet that the fixed side of the spread will stay higher than the floating side of the spread, and stay in a reasonable range according to historical trends. With **yield-curve spread trades**, the hope is that bond prices will deviate from the overall yield curve only in the short term, and will revert to normal spreads over time. **Mortgage spread trades** are bets on prepayment rates, while **fixed income volatility trades** are bets that the implied volatility of interest rate caps have a tendency to be higher than the realized volatility of, for example, a Eurodollar futures contract. **Capital structure** or **credit arbitrage trades** try to capitalize on mispricing among different types of securities (e.g., equity and debt).

Convertible Arbitrage

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock, taking advantage of a perceived pricing error made in the security's conversion factor. The number of shares shorted is based on a delta neutral or

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market neutral ratio. The plan is for the combined position to be insensitive to underlying stock price fluctuations under normal market conditions.

The return to convertible arbitrage hedge funds comes from the liquidity premium paid by issuers of convertible bonds to hedge fund managers, for holding convertible bonds and managing the inherent risk by hedging the equity part of the bonds.

Long/Short Equity

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations. Examples are shifts from value to growth, small- to mid-cap stocks, and net long to net short. Trades in equity futures and options can also take place.

Thirty to forty percent of hedge funds are long/short. Long/short managers are stock pickers with varying opinions and abilities, so performance tends to be very idiosyncratic. Underpriced or under-researched stocks are favored, as are small stocks, on the long side. On the short side, low liquidity makes small stocks and foreign stocks less attractive. Long/short equity funds have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated Short Bias

Funds with a dedicated short bias tend to take net short positions in equities. Sometimes the short position strategy is implemented by selling forward. To manage risk, managers take offsetting long positions and stop-loss positions. The returns are negatively correlated with equities.

Emerging Markets

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets. These markets are usually identified in terms of gross national product (GNP) per capita. China, India, Latin America, Southeast Asia, parts of Eastern Europe, and parts of Africa are examples of emerging markets. These funds have a long bias because it is more difficult to short securities in emerging markets.

Equity Market Neutral

When reviewing equity market neutral hedge fund strategies, research shows that there is not one common component (or risk factor) in their returns. Different funds utilize different trading strategies, but they all have a similar goal of trying to achieve zero beta(s) against a broad set of equity indices.

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Hedge Fund Performance

LO 67.7: Describe the historical portfolio construction and performance trend of hedge funds compared to equity indices.

Twenty-seven large hedge funds were identified in 2000, and research has been done to determine if these hedge funds are truly a separate asset class, not correlated to equity or bond indices. Hedge fund returns were regressed against an 8-factor model used to analyze hedge fund performance. Findings were that hedge fund portfolios had no significant exposure to stocks and bonds. As an equally weighted portfolio, this portfolio of 27 top performing hedge funds had a large alpha of 1.48% per month. There was a persistent exposure to emerging markets, but other factor betas showed a lot of variability. Also, alpha declined over time, and there was not a persistent directional exposure to the U.S. equity market. Measurement bias may have affected these results somewhat.

Alternatively, a strategy of investing in a portfolio of the top 50 large hedge funds was tested using data from 2002 to 2010. Two test portfolios were constructed:

- The first test portfolio attempted to mimic performance of a strategy of investing in the top funds in equal dollar amounts, and rebalancing at the end of each calendar year. The funds were selected based on the assets under management at year-end 2001.
- A similar portfolio was constructed using top funds based on year-end 2010, rather than 2001.

For the first portfolio, the intent was to give a lower and upper bound of performance which investors could achieve, by just following a strategy of investing equally in the top 50 large hedge funds, and rebalancing yearly. The second portfolio was "foresight assisted."

In evaluating performance characteristics, the first portfolio did not have a significant alpha, while the foresight-assisted portfolio had a monthly alpha of 0.53%, and was statistically significant at the 1% level. Compared to hedge fund returns prior to 2002, the decline in alpha is consistent with the thinking that there is more competition in the hedge fund industry. It should, however, be noted that there is no significant negative alpha.

Looking at the top 50 hedge funds versus all hedge funds, the top 50 portfolios (both versions) demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices.

During the 2002 to 2010 time period, the top 50 hedge fund portfolios (with the exception of the foresight-assisted portfolio), and the two broad hedge fund indices, DJCSI and HFRI, all outperformed the equity market, as measured by the S&P 500 index. In sum, analysis of large hedge funds shows that managers are still delivering alpha return relative to peers, and also have low exposure to the U.S. equity market. These factors continue to attract institutional investors.

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Convergence of Risk Factors

LO 67.8: Describe market events which resulted in a convergence of risk factors for different hedge fund strategies, and explain the impact of such a convergence on portfolio diversification strategies.

Theoretically, diversification among hedge fund strategies should protect investors, but there are certain events that affect all, or mostly all, strategies, as they all undergo stress at the same time. Portfolio diversification implodes, and seemingly diverse hedge fund portfolios *converge* in terms of risk factors during times of stress.

The first recorded major market event for hedge funds was in March and April of 1994 when unexpected changes in interest rate policy were set by the Federal Reserve. This caused two months of losses by seven of the ten style-specific sub-indices in the DJCS family. Exceptions were short sellers and managed futures funds. Merger arbitrage funds earned a positive return in March, while equity market neutral funds had a positive return in April.

Another major event was in August 1998 right before the collapse of LTCM. Eight of the ten niche DJCS style sub-indices had large losses. Short sellers and managed futures funds avoided losses. The losses occurred primarily due to market-wide liquidation of risky assets and the high amount of leverage on LTCM's balance sheet.

With hedge fund investing, leverage has a magnifying effect on gains and losses, and risk is on both sides of the balance sheet. There were events prior to the 2007–2008 financial crisis that illustrated how much a market-wide funding crisis can significantly impair leveraged positions. In August 2007, for the first time, all nine specialist style sub-indices lost money. The only positive return was from short sellers. During the peak of the financial crisis from July to October 2008, July to September brought losses for all hedge fund styles (excluding short sellers). When leveraged positions are forced to liquidate, losses can be high.

The point is that when there is a market-wide funding crisis, it is difficult to mitigate risk by simply spreading capital among different hedge fund strategies. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

Risk Sharing Asymmetry

LO 67.9: Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry.

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

The problem occurs when the incentive fee that a hedge fund manager is entitled to, typically 15–20% of new profits [profits above a high water mark (HWM)], encourages a fund manager to take outsized risks. This tends to increase the future loss-carried-forward if

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and when these bets fail. If the fund fails, the same fund manager can start up a new hedge fund.

However, there is an opportunity cost involved in cases where a hedge fund manager closes a fund. It is costly in terms of harming the track record of the manager and affects reputation risk of both the manager and the fund company. All things considered, this cost does not totally mitigate the basic principal/agent conflict.

Investors may be best served to invest in funds for which the fund managers invest a good portion of their own wealth. As much as this issue has been discussed, the basic structure of how fund managers are compensated has not changed.

Impact of Institutional Investors

LO 67.10: Explain the impact of institutional investors on the hedge fund industry and assess reasons for the growing concentration of assets under management (AUM) in the industry.

As mentioned earlier, beginning in 2000, institutional investor funds flowed into hedge funds, and assets under management in the hedge fund industry grew from $197 billion at 1999 year-end to $1.39 trillion by 2007 year-end. Institutional investors were rewarded for allocating capital to a much higher fee environment. Three hedge fund performance databases, DJCSI, HFRI, and HFRFOFI, respectively, reported cumulative performance of 72.64%, 69.82%, and 38.18% from the 2002 to 2010 time period, compared to the S&P 500 index return of 13.5%. The S&P 500 index had a 16% standard deviation during that period, versus annualized standard deviations of return of 5.84%, 6.47%, and 5.51%, for the respective hedge fund indices.

With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance. Some institutional investors were seeking absolute performance, while others were seeking alternative sources of return beyond equities. There is some concern that there is no identifiable alpha associated with hedge fund investing, so it is increasingly important that hedge fund managers differentiate themselves from their peers.

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Key Concepts

LO 67.1

Hedge funds are private investments and have very little financial regulation. They tend to be highly leveraged, and managers make large bets. On the other hand, mutual funds are regulated and more structured.

LO 67.2

There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is selection bias contained in hedge fund databases.

LO 67.3

There have been major events affecting the hedge fund industry, including large losses following a change in Fed policy in 1994, the LTCM collapse in 1998, and the dot-com collapse in 2001.

LO 67.4

From 1999 to 2007, investors in hedge funds shifted from exclusively private wealth to institutions, including foundations, endowments, pension funds, and insurance companies.

LO 67.5

Alpha is the return in excess of the compensation for risk. Beta is a measure of the systematic risk of the security or portfolio relative to the market as a whole. Firms may independently manage alpha and beta. This is known as separating alpha and beta. Managers can use investment tools to pursue alpha while sustaining a target beta for the portfolio.

LO 67.6

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. The payoff function of this strategy is similar to a lookback straddle.

Global macro managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices, and do better during extreme moves in the currency markets.

Merger arbitrage funds bet on spreads related to proposed merger and acquisition transactions, and perform poorly during major market declines.

Distressed hedge funds invest across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a

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long-bias. These hedge fund managers try to profit from an issuer's ability to improve its operation, or come out of a bankruptcy successfully.

Fixed income arbitrage funds try to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. Their performance is correlated to changes in the convertible bond default spread.

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock.

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations, and have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated short bias funds tend to take net short positions in equities, and their returns are negatively correlated with equities.

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets.

Equity market neutral funds attempt to achieve zero beta(s) against a broad set of equity indices.

LO 67.7

The top 50 hedge funds demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices. Hedge fund managers are still delivering alpha relative to peers, and also have low exposure to the U.S. equity market.

LO 67.8

Diversification among hedge fund strategies may not always be effective due to the convergence of risk during times of extreme market stress. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

LO 67.9

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

LO 67.10

Institutional investors flocked to hedge funds beginning in 2000. With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance.

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Concept Checkers

1. What critical shift occurred in the hedge fund industry following the collapse of Long-Term Capital Management (LTCM) in 1998 and the dot-com bubble burst in 2001?
   A. There was a significant drop in assets under management in the hedge fund industry.
   B. There was a large influx of institutional investors investing in hedge funds.
   C. Reporting within the hedge fund industry became more regulated than mutual funds.
   D. There was a significant increase in hedge fund failures.

2. Which of the following hedge fund strategies would be characterized as an "asset allocation" strategy that performs best during extreme moves in the currency markets?
   A. Global macro.
   B. Risk arbitrage.
   C. Dedicated short bias.
   D. Long/short equity.

3. Comparing hedge fund performance during the time period 2002–2010 to earlier time periods, how would monthly alpha compare, if looking at large hedge funds?
   A. Alpha was higher in the 2002–2010 time period.
   B. Alpha remained constant over both time periods.
   C. A "foresight-assisted" portfolio did not have a statistically significant alpha during the 2002–2010 time period.
   D. There was a decline in alpha in the 2002–2010 time period.

4. Jamie Chen, FRM, is considering investing a client into distressed hedge funds. Which of the following investments would serve as the best proxy for the types of returns to expect?
   A. Convertible bonds.
   B. Small-cap equities.
   C. Managed futures.
   D. High-yield bonds.

5. What would be an ideal approach for a hedge fund investor who is concerned about the problem of risk sharing asymmetry between principals and agents within the hedge fund industry?
   A. Focus on investing in funds for which the fund managers have a good portion of their own wealth invested.
   B. Focus on diversifying among the various niche hedge fund strategies.
   C. Focus on funds with improved operational efficiency and transparent corporate governance.
   D. Focus on large funds from the "foresight-assisted" group.

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Concept Checker Answers

1. **B** During the time period following the dot-com collapse, hedge funds outperformed the S&P 500 with a lower standard deviation, which attracted institutional investment.

2. **A** A global macro fund does better if there are extreme moves in the currency markets. Along with managed futures, global macro is an asset allocation strategy. Managers take opportunistic bets in different markets. The strategy has a low correlation to equities.

3. **D** Comparing the two different time periods, there was a decline in alpha due to more competition in the hedge fund industry.

4. **D** Distressed hedge funds have long exposure to credit risk of corporations with low credit ratings. Publicly traded high-yield bonds are a good proxy for the returns to expect.

5. **A** The incentive fee structure within the hedge fund industry has not really changed over the years, and there is incentive for managers to take undue risks in order to earn fees. Thus, there should be a focus on investing in funds for which the fund managers have a good portion of their own wealth invested.

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The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Performing Due Diligence on Specific Managers and Funds

Topic 68

Exam Focus

This topic emphasizes the reasons investors should perform due diligence on potential investments. It provides a thorough list of items to consider in the due diligence process. For the exam, understand in detail the steps involved in evaluating a manager, a fund's risk management process, and a fund's operational environment.

Past Fund Failures

LO 68.1: Identify reasons for the failures of funds in the past.

Investors should be familiar with the reasons past funds have failed to ensure they can avoid investing in a failing fund. Following is a concise list of reasons past funds have failed.

1. **Poor investment decisions**. Could be a series of decisions ("domino effect") or a very calculated risk on a specific investment that backfired.

2. **Fraud**. Fraud could occur in several forms including accounting (e.g., misstating asset book values or misstating income), valuation (e.g., misstating asset market values), and theft of funds.

3. **Extreme events**. Events occurring that would otherwise occur with very low probability or were unexpected (e.g., market crashes).

4. **Excess leverage**. Related to making poor investment decisions. Leverage goes both ways. That is, it magnifies gains but also magnifies losses.

5. **Lack of liquidity**. Too many capital withdrawals and redemptions to honor at once, thereby creating a squeeze on cash flow and an inability to meet all capital withdrawals and redemptions.

6. **Poor controls**. Closely related to fraud. Lack of supervision could result in excessive risks being taken that lead to losses large enough to bankrupt the fund.

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7. **Insufficient questioning.** Often in a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns over information they have discovered that would question the merits of the investment manager and/or investment. Ideally, all due diligence team members should be encouraged to play the role of "devil's advocate" when appropriate and raise reasonable concerns as early as possible, especially before they reach the committee stage.

8. **Insufficient attention to returns.** Investment funds attempting to reduce operational risk sometimes overcompensate by implementing excessive controls and may end up bearing too many expenses and not generating enough returns. Ideally, there is a healthy balance between generating strong returns while taking on a reasonable level of risk.

Due Diligence Elements

LO 68.2: Explain elements of the due diligence process used to assess investment managers.

Prior to investing, an investor performs due diligence on a potential investment manager, which involves assessing the manager, the fund, and the investment strategy. Information such as the investment background, manager's reputation (e.g., education, employers), and past performance have always been key considerations but are insufficient on their own.

An additional element of due diligence involves assessing the investment process and risk controls. The starting point is a review of the fund's prospectus or offering memorandum. Additionally, an attribution analysis could be performed to determine how the returns were generated. Were they generated through the skill and control of the manager, luck, and/or factors beyond the manager's control? In addition, was the amount of return in line with the amount of risk taken?

Another related element is assessing the fund's operations and business model. In general, are there internal controls and policies in place to preserve the investors' funds? Specifically, are the controls in place sufficiently robust to detect and prevent fraudulent activities or are limits imposed on managers to seek higher level approval for transactions exceeding a certain dollar amount or frequency? Is there appropriate segregation of duties between the front office and the back office? What is the process and frequency of asset valuations? What is the fee structure and are there any additional fees after a specific threshold? Are there any limitations or blackout periods on redemptions?

In the end, investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not get caught up with a manager's past successes.

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Manager Evaluation

LO 68.3: Identify themes and questions investors can consider when evaluating a manager.

Manager evaluation is not a task that should be taken lightly by potential investors. This process can be broken down into four areas including strategy, ownership, track record, and investment management.

Strategy

General questions regarding a manager's strategy may include:

- Does the manager follow a particular investment style (e.g., growth, value)?
- Are there any current "trends" in the fund or specializations in specific securities, industries, or sectors?
- How has the fund changed its investment style or rebalanced its holdings over the past year? What changes are contemplated in light of anticipated market conditions?
- What is the extent of turnover and liquidity in the fund? What market signals are used to determine whether to exit or enter a position?
- What mechanisms are in place to limit any potential losses in the fund?
- To what extent is quantitative analysis and modeling utilized in the investment process? Have any models been developed or tested to date?
- Are short sales used to generate excess profits or to hedge? How successful or detrimental have they been so far?
- Are derivatives used in the portfolio? If so, are they used for hedging or speculative purposes?
- How does the trade execution process work? Does a central trading desk exist for maximum efficiency?
- What is the extent of any investment in private company securities and their role in the overall investment strategy?
- What is the tradeoff between maximizing current returns versus long-term fund growth?
- Has the fund ever been closed or provided investors with a return of capital?

Ownership

Ownership interests often help align the interests of the investment team and the investors. They can be useful in attracting and maintaining quality staff, thereby enhancing and/or continuing to generate strong investment returns for investors.

Therefore, potential investors should inquire as to whether any members of the investment team (e.g., traders, portfolio managers, research analysts) have ownership interests in the firm.

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Track Record

Specific questions about the manager's and fund's track records may include:

- How does the past performance of the manager and/or fund compare to its peers and/or funds that follow the same or similar investment philosophy?
- Has past performance been audited or verified by a third party?
- Is there sufficient performance history to perform trend and/or attribution analysis? How did the manager or fund perform during market downturns?
- What were the investment returns relative to the size of the investment assets?
- Are most or all of the staff on the investment team that generated those past results still employed by the firm?

Investment Management

Inquiries during manager interviews may include:

- What is/was the manager's investment strategy for generating excess returns?
- How did the manager cope with tough market periods?

Reference checks on managers could include the following individuals:

- Former employers: Was the manager a leader or follower? Proactive or reactive? A team player or individualist?
- Current and former colleagues, clients, and other independent parties: Ensure consistency but if there are mixed reviews, follow up for explanations and/or obtain clarification from the manager.
- Current and former investors: What good and bad investment experiences did they have with the manager?

Background checks on managers may include the following questions/activities:

- Obtaining comprehensive background check reports on the manager.
- Review the Form ADV filed by the manager with the SEC and state securities authorities. It contains general information about the business as well as more detailed information such as fees, services provided, conflicts of interest, and background of key personnel.
- Has the manager consistently demonstrated herself to be a person of integrity? This could be verified by examining public databases and the SEC website to look for any past or current instances of litigation or criminal behavior.
- Has the manager demonstrated strong personal financial responsibility? This could be verified by examining personal credit reports and bankruptcy reports.
- Are the manager's stated representations accurate? This could be verified by inquiring with auditors and brokers who are currently working with the manager or have worked with the manager in the past.
- What is the extent of the manager's involvement in any related party transactions?

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Risk Management Evaluation

LO 68.4: Describe criteria that can be evaluated in assessing a fund's risk management process.

A proper risk management process should contain an assessment of the following areas: risk, security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

Risk

- Assess the applicable systematic risk factors (i.e., regular market risks common to most or all funds) and unsystematic risk factors (i.e., risks specific to the manager, fund, or strategy).
- Determine whether written policies and procedures exist regarding measuring and monitoring risk.
- Determine whether a risk committee exists that would receive such measurements. If so, how often are they reported?
- Evaluate the extent of the risk management culture among the various types of employees. For example, how actively involved are employees with managing and mitigating the firm's risks on a day-to-day basis?
- Assess the information technology resources used to quantify the risks. For example, are they reliable and do they measure items consistently between traders and portfolio managers?
- Identify the existence and structure of any risk models. What are their inputs and assumptions? Have the models been tested and are they robust?

Security Valuation

- Identify the proportion of fund assets that are objectively valued through reliable market prices versus those that are more subjectively valued by the broker or through simulation.
- Examine the independence of valuations. Is valuation performed by the fund administrator (generally more independent) or by the fund manager (generally less independent)?
- Determine if prices may be overridden for valuation purposes. If so, by whom? Is there documentation or an approval process?

Portfolio Leverage and Liquidity

- Assess the sources of leverage as well as the current and historical levels of leverage.
- Calculate the current level of liquidity and observe how it has changed over time. The current level is especially relevant because of the impact on portfolio investment capacity and whether it can take on more investment capital.
- Within a stated investment strategy, excessive leverage and/or illiquidity could generate actual returns that are significantly different than expected (i.e., no longer comparing apples to apples), thereby requiring an adjustment in expected returns.

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Exposure to Tail Risk

- Analyze information about the fund to conclude whether the fund's return distribution possesses skewness or kurtosis.
- Discuss the possibility of tail risk with the manager and determine whether the manager has sufficiently mitigated the risk or whether further action is required by the investor.

Risk Reports

- Review risk reports prior to investing in the fund. Investors should receive these risk reports on a regular basis (e.g., monthly, quarterly, annually) whether they are prepared in-house or by a third party.
- Analyze key risk metrics and compare them to other similar funds for benchmarking purposes and for determining if any unusual risks exist in the fund.

Consistency of the Fund Terms with the Investment Strategy

- Examine the general fee structure of the fund and determine whether it is consistent with similar funds.
- Identify the existence of any additional fees after a specific threshold (e.g., high-water mark, hurdle rate).
- Evaluate whether high fees are being paid to managers in search of market alpha (fair) as opposed to beta (unfair).
- Identify the existence of any limitations or blackout periods on redemptions.

Operational Due Diligence

LO 68.5: Explain how due diligence can be performed on a fund's operational environment.

Investors should focus on several key areas when performing operational due diligence on a fund. The focus areas are internal control assessment, documents and disclosure, and service provider evaluation.

Internal Control Assessment

A starting point in due diligence is examining the qualifications and attitudes of the personnel. For instance, does the CEO believe in controls and compliance with the rules? An analyst must also assess whether the internal control staff have sufficient technical and work experience to perform their compliance duties properly. Have they been properly trained and do they continue to expand their skills in compliance? Some assurance may be required regarding whether the back and middle office managers are sufficiently experienced in performing supervisory duties. Finally, background checks on critical internal control staff members might be required.

Examining the fund's policies and procedures may also be useful. Related documents may cover areas such as trading, derivatives usage, and transaction processing. One drawback is that these documents tend to be general and only demonstrate the intention to have a strong control environment. In other words, merely reading the documents provides little assurance that the policies and procedures are actually being followed or are effective. It is

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usually a good sign if a fund has been proactive and obtained an audit report and opinion on the effectiveness of its controls. If this report is available, it should be reviewed.

The due diligence process should include an examination of the in-house or outsourced compliance system that is in place. Examples of specific items to consider include the code of ethics (if one exists) and any restrictions on employee trading and related-party transactions.

There should be an investigation into how the funds deal with counterparty risk arising from OTC derivatives and other counterparties. Is such risk mitigated by dealing with more than one counterparty? Are the counterparties monitored for risk on a daily basis?

Finally, there should be an assessment as to the effectiveness of corporate governance. Is it pervasive throughout the organization? Are examples of internal control "breaches" followed up with appropriate actions to remedy and prevent future recurrence?

Documents and Disclosure

As part of the due diligence process, investors must confirm with the fund's legal counsel its involvement in preparing the original version of the fund documents as well as any subsequent revisions. The investor should also confirm if the law firm remains as the fund's legal counsel. A physical check of the documents should be made to look for any changes made after the date indicated on the documents.

The investor should corroborate the terms of the offering memorandum by examining other documents such as the Form ADV, subscription agreement, and investment management agreement. Consistency is important here. Terms relating to fees, redemption rights, liquidity, and lockups should be examined closely and clarified with the manager if required.

Conflicts of interest that are disclosed in the offering memorandum should be scrutinized carefully. Lack of clarity in the disclosure may be a red flag and warrant further discussion with the manager and/or require independent information.

Similarly, lack of clarity or sufficiency in the disclosure of risks may warrant further investigation. The discussion of very general or irrelevant risk factors may be cause for concern.

The focus of any due diligence should be on the manager. As a starting point, the potential investor should determine the extent of the manager's authority. Are the provisions very broad (potentially more risky) or quite specific? Is the manager subject to limitations on the amount of leverage employed or on the percentage of the fund invested in specific securities, sectors, or industries? Can the manager be indemnified for his actions outside of fraud, gross negligence, or malicious intent? Additionally, there should be a consideration of the manager's reporting duties to investors (e.g., audited financial statements, disclosure of the tax treatment of the fund's income and transactions).

In analyzing the financial statements, the investor should begin by ensuring the audit opinion is unqualified (i.e., the auditor believes the financial statements contain no material misstatements). The balance sheet and income statement should be examined for

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consistency with the fund's investment strategy (e.g., a high leverage fund should have high interest expense on the income statement and high liabilities on the balance sheet). Any inconsistencies should be discussed with the manager on a timely basis. In addition, the footnotes (which are also audited) should be examined carefully since they provide more detailed information on key items (e.g., contingent liabilities, related-party transactions) than the corresponding financial statements.

Fees paid to the manager by the fund should be scrutinized and recalculated. They should be corroborated with the offering memorandum. Specifically, there should be a check of any incentive fees paid in loss years.

Finally, there should be a check for the level of net contributions to the fund by the general partner. Any fund withdrawals should be questioned.

Service Provider Evaluation

Third-party service providers may be hired by a fund for trade execution, information technology, valuation, verification, and asset safeguarding purposes.

A starting point for assessing the actual service providers is to examine the internal control letters issued by its auditors and its audited financial statements. Further due diligence could be performed through in-person discussions regarding the service provider's role.

Business Model and Fraud Risk

LO 68.6: Explain how a fund's business model risk and its fraud risk can be assessed.

In addition to the previous due diligence, potential investors need to closely examine the fund to ensure that the risks associated with its business model and potential fraud are not excessive.

Business Model Risk

Evaluating business model risk requires assessing whether managers know how to operate the business as well as generate high returns. Typical risks, potentially leading to failure and closure of the fund, include a lack of cash and working capital, a lack of a succession plan, and excessive redemptions in a short period of time.

A fund's business model risk can be assessed by performing the following tasks:

- Examining the nature of the revenues and expenses. For example, are revenue items stable, recurring, or one-time? Can costs be reduced or are they increasing uncontrollably?
- Calculating the percentage of revenues derived from variable incentive or performance fees (that may not materialize in market downturns).
- Assessing the significance of the gap between management fees (revenue) and operating expenses.

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- Considering the sufficiency of the amount of working capital (especially cash) in place to cover revenue shortfalls and/or expense overages for a reasonable period of time.
- Determining how frequently budgets are created and for what period of time.
- Determining the fund's breakeven points in terms of assets under management and required performance level. Comparing those amounts to current (actual) and future (projected) amounts.
- Ascertaining if there is sufficient personnel or capacity to increase the fund's investment asset base.
- Ascertaining the existence of key person insurance on relevant individuals and the existence of a succession plan.

Fraud Risk

Fraud risk can always exist even though extensive due diligence has been performed on the manager and fund prior to investing. A fund's fraud risk can be assessed by determining the existence of the following factors:

- Frequent related-party transactions, including trading through a broker or using a valuator who is a related party.
- Frequent instances of illiquidity, including significant concentrations of illiquid investments (especially those that are valued by the manager only).
- Frequent litigation as a defendant, especially regarding claims of fraud.
- Unreasonably high (stated) investment returns.
- Frequent personal trading by the manager of the same or similar securities as those held by the fund.
- Frequent shorting transactions.

Fraud risk may be mitigated by performing the following actions:

- Check the SEC website for any prior regulatory infractions.
- Check court records for any prior litigation and bankruptcy records for examples of financial irresponsibility.
- Inquire with service providers for assurance over their competence and independence from the manager.
- Perform extensive background checks on the manager.

Due Diligence Questionnaire

LO 68.7: Describe elements that can be included as part of a due diligence questionnaire.

Properly designed due diligence questionnaires that are thoroughly and honestly answered by respondents can yield valuable information to a potential investor and may provide a list of concerns that need further assessment. The questionnaire should make the following inquiries:

1. Inquiry into general information on the manager provides a starting point in the due diligence process. Examples of such information include:
    - Confirmation of proper registration with regulatory authorities.
    - Determination of ownership form (e.g., corporation) and structure.
    - Identification of key shareholders.

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- Reference checks.
- Information on past performance.
- Business contact information.

2. Inquiry into general information on the fund also is critical. Examples of general information that should be collected include:
   - Fees.
   - Lockup periods.
   - Redemption policies.
   - Primary broker.
   - Fund director.
   - Administrator.
   - Compliance: auditor and legal advisor.
   - Financial: assets under administration, investment capacity, and historical performance (also see financial statements).
   - Historical drawdown levels.

3. Inquiry into execution and trading as well as service providers may provide some insight on the speed and accuracy of transaction processing and the existence of related-party service providers, the latter of which may raise red flags with potential investors as discussed earlier.

4. Inquiry regarding the firm's third-party research policy may be useful to determine a fund's sources of research information, thereby allowing the assessment of the extent and quality of the due diligence performed by the fund in its investment process.

5. Inquiry regarding compliance processes, the existence and degree of involvement of in-house legal counsel, and the existence of anti-money laundering policy and procedures may help provide comfort that the fund and its managers have a desire to operate in an ethical manner and/or within the boundaries of the law.

6. Inquiry into the existence of information regarding disaster recovery and business continuity plans as well as insurance coverage and key person provisions may provide some assurance regarding the stability of the firm and, therefore, the safety of any invested funds.

7. Inquiry into the investment process and portfolio construction provides the potential investor with information required to make an informed decision whether the overall risk and return profile of the fund is consistent with the investor's investment objectives.

8. Inquiry into risk controls such as leverage, liquidity, asset concentrations, portfolio diversification, and market risk factors give the investor a more complete picture of the investment risks and how the managers attempt to manage and mitigate them.

The existence of financial statements, especially if audited with an unqualified opinion, provide objective and historical financial information on the fund that can be used to assess performance. Information on the composition of the invested assets may also be helpful to the potential investor. Finally, interim statements (not necessarily audited) may provide more timely information to make a more current assessment of the fund by the potential investor.

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Key Concepts

LO 68.1

Past fund failures can be attributed to poor investment decisions, fraud, extreme events, excess leverage, lack of liquidity, poor controls, insufficient questioning, and insufficient attention to returns.

LO 68.2

The due diligence process for assessing investment managers should include information on the investment background and reputation of the managers and past performance. In addition, there should be an assessment of the fund's investment process, risk controls, operations, and business model.

LO 68.3

In evaluating a manager, investors should consider four broad themes including strategy (e.g., evolution, risk management, quantification, types of investments), ownership, track record (e.g., comparison with peers, independent verification of results), and investment management (e.g., manager interviews, reference checks, background checks).

LO 68.4

Criteria that could be used in assessing a fund's risk management process includes risk (e.g., types, culture, quantification/models), security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

LO 68.5

Performing due diligence on a fund's operating environment focuses on:

- Internal control assessment (i.e., qualifications and attitude of personnel, written policies and procedures, compliance system, counterparty risk, effectiveness of governance).
- Documents and disclosure (i.e., confirmations with the fund's legal counsel regarding fund documents, corroborating terms of the offering memorandum, conflicts of interest, disclosure of risks, manager's authority, manager's reporting duties to investors, financial statements, and fees paid to the manager, net contributions/withdrawals by the general partner).
- Service provider evaluation.

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LO 68.6

Business model risk can be assessed by considering revenues and expenses (detailed examination), sufficiency of working capital, existence of budgets, computation of breakeven points, ability to increase investment asset base, existence of key person insurance, and existence of a succession plan.

Fraud risk can be assessed by considering the existence of related-party transactions, illiquidity, litigation, unreasonably high (stated) investment returns, personal trading by the manager of the same or similar securities as those held by the fund, and shorting transactions.

LO 68.7

Items to include as part of the due diligence questionnaire include general information on the manager and the fund, execution and trading, service providers, third-party research policy, compliance processes, existence and degree of involvement of in-house legal counsel, existence of anti-money laundering policy and procedures, existence of information regarding disaster recovery and business continuity plans, insurance coverage, key person provisions, details of the investment process and portfolio construction, risk controls, and information contained in the fund's financial statements.

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Concept Checkers

1. Based on historical evidence, which of the following factors is least likely to result in the eventual failure of a hedge fund?
   A. Excessive controls in place.
   B. Taking on more systematic risk.
   C. Making decisions in a committee setting.
   D. Materially misstated financial statements.

2. In performing due diligence on a potential investment manager, which of the following factors is the least important for the investor to consider?
   A. Risk controls.
   B. Business model.
   C. Past performance.
   D. Investment process.

3. Which of the following items is least likely to be included as requested information on a due diligence questionnaire?
   A. Insurance coverage.
   B. Returns attribution analysis.
   C. Disaster recovery procedures.
   D. Anti-money laundering policy.

4. Which of the following statements regarding the assessment of a fund's risk management process is correct?
   A. The periodic valuation of a fund's securities is best performed by the fund manager.
   B. The existence of written policies and procedures for internal controls is useful in measuring and monitoring risk.
   C. The risk reports received by investors are preferably prepared by a third-party risk provider instead of by the fund itself.
   D. The key requirement for information technology resources used to quantify the risks is that they measure items consistently.

5. Lisa Tahara, FRM, is considering an institutional investment in a hedge fund that has experienced volatile and generally positive returns in the past. Which of the following considerations about the fund's track record is least relevant for consideration in her investment decision?
   A. Size of investment assets.
   B. Absolute level of past returns.
   C. Verification of returns by a third party.
   D. Employment continuity of the investment team.

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Concept Checker Answers

1. **B** If a fund takes on more systematic risk (i.e., regular market risk), it is less likely to result in a failure unless there is a significant market downturn. Taking on more unsystematic risk, however, is more likely to result in a failure. Excessive controls to reduce operational risk may be a good idea but may also result in excessive expenses and insufficient returns, thereby leading to a possible failure of the fund.

   In a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns. Materially misstated financial statements are a form of accounting fraud, which significantly increases the risk of the eventual failure of a fund.

2. **C** Investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not be unduly concerned with a manager's past successes given that past performance is not always indicative of future performance. Risk controls, the business model, and the investment process are all fundamental parts of the due diligence process.

3. **B** A returns attribution analysis could be performed to determine how a fund's returns were generated. Return attributions are not generally part of a due diligence questionnaire but such an analysis could subsequently be performed based on some of the information received from the questionnaire. The other items (insurance coverage, disaster recovery procedures, and anti-money laundering policy) are all standard items that would be found in most, if not all, due diligence questionnaires.

4. **D** It is very important for the information technology resources used to quantify risks to measure items consistently. Securities valuation is an important and potentially subjective task, therefore, independence and objectivity is critical. Policies and procedures tend to be general and only demonstrate the intention to have a strong control environment. Their existence alone provides little assurance that they are properly measuring and monitoring risk. In general, the reporting of risk measures is a more objective task and as a result, there is little or no preference for the reporting to be done internally or externally.

5. **B** The absolute level of past returns is least relevant here given the volatile returns in the past. Also, past returns are not an assurance of similar returns in the future. The relative level of returns is more important than the absolute level. Verification of returns by a third party provides assurance that the return calculations were computed fairly and accurately by the fund. It is relevant to ascertain whether most or all of the staff on the investment team that generated the past results are still currently employed by the fund. It provides some (but not absolute) assurance that similar returns may be generated in the future.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Clearinghouse Overconfidence

Topic 69

Exam Focus

After the 2007–2009 financial crisis, regulations focused on the complex financial instruments that magnified the crisis. The Dodd-Frank Wall Street Reform Act instructed regulators to establish clearinghouses for these risky financial instruments with the expectation that this would reduce systemic risk. For the exam, understand the advantages of using clearinghouses for trading derivatives. Also, understand the "too big to fail" concept with respect to clearinghouses and the clearinghouse shortcomings in reducing risk.

Clearinghouse Advantages

LO 69.1: Synthesize the advantages of using clearinghouses for trading derivatives.

There are five key advantages of clearinghouses with respect to derivatives: (1) standardization and improved price transparency, (2) centralization of counterparty risk, (3) centralization of collateral collection, (4) mutualization of risk, and (5) netting.

Standardization and Improved Price Transparency

Financial markets are often opaque. Due to this characteristic, an infrequent trader can overpay for an asset while a frequent trader can better assess price efficiency. A clearinghouse can make pricing public with standardized products and reporting trades regularly. This information provides infrequent traders with better information regarding fair asset values.

Centralization of Counterparty Risk

Many financial trades are structured as open-ended trades. This means that the size of a trader's obligation varies based on market prices until the trade matures. The party due payment wants protection in the event that its trading partner (i.e., its counterparty) cannot pay. To reduce the risk of insolvency, traders post collateral. There are both trading and regulatory advantages to centralizing counterparty risk:

- *Trading advantages.* Traders must assess both the deal's market value and the counterparty's credit quality to determine collateral requirements. Profitable paper trades are meaningless if the counterparty is unable to pay its obligations. Centralized clearing increases efficiency by putting the task on the clearinghouse, not the traders.
- *Regulatory advantages*. Centralization can facilitate sound regulation because it provides regulators with a more accurate view of the market and its firms.

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Centralization of Collateral Collection

Centralizing the collection of collateral potentially makes trading cheaper and safer. For example, if insurance and financial services company American International Group (AIG) had been required to trade with a clearinghouse, it would have been required to post collateral to cover potential trade obligations. Profitable trades would provide some collateral to back up those trades to bolster its losing trades.

During the recent financial crisis, excess collateral was often demanded given the inability to determine the true health of financial firms. A clearinghouse would ideally have required adequate collateral prior to the crisis, and then made good on trades where failed firms were unable to fulfill their obligations.

Mutualization of Risk

Clearinghouse members initially post capital to the clearinghouse. This capital becomes a guarantee fund for trades, spreading the risks of potential trading failure among all members. In theory, the first domino is prevented from falling or, if it does, costs are spread out across multiple financial institutions (i.e., a risk-sharing mechanism exists). In practice, this may require adjustment to the operation of a clearinghouse. For example, the Chicago Mercantile Exchange is anticipated to take on many of the new clearing mandates. However, it only has $20 billion in capital while the U.S. government had to put up $180 billion to bailout AIG.

Netting

Clearinghouse members would benefit from netting. Netting enables counterparties with multiple derivatives contracts to net their obligations. For example, assume Firm A has obligations running to it and from it. Firm B owes Firm A $2 billion (an asset) while Firm A owes Firm C $2 billion (a liability). If debts are handled one by one, Firm B pays $2 billion to Firm A and Firm C demands its $2 billion from Firm A. If Firm A is having severe financial difficulties, Firm C must face off against other Firm A creditors for a piece of the $2 billion. If, instead, Firm A enters a financial freefall and is unable to fully pay the $2 billion to Firm C, this failure to pay may cause Firm C to also fail. This scenario is an example of contagion.

The addition of a clearinghouse would have stabilized this sequence of obligations. Before Firm A was in financial trouble, the clearinghouse would have taken over Firm C's claim on Firm A as well as Firm A's claim on Firm B. The clearinghouse would obtain the $2 billion from Firm B. Instead of turning the cash over to Firm A, which would use it for all its creditors, not just Firm C, the clearinghouse would pay Firm C its $2 billion. Firm C, having received its cash, would not fail given that there is no delay, or reduction, in the cash it receives as opposed to the potential lawsuits, bankruptcy, and unavailable/insufficient funds in the original scenario. In this netting example, one domino (i.e., Firm A) falls, but the entire row of dominoes does not (i.e., contagion does not spread).

Traders also benefit from a clearinghouse, as their net obligations are typically lower than their gross obligations due to having both profitable and unprofitable positions with several

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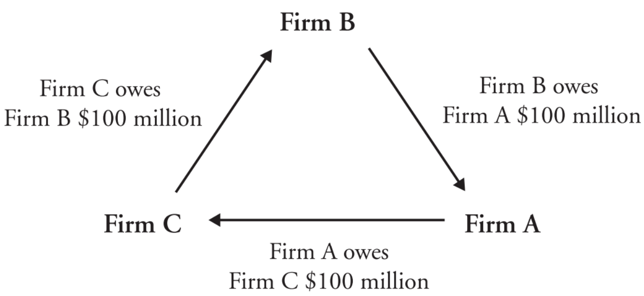
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different counterparties. Netting would allow quick trade settlement, which avoids slow payments, lawsuits, and bankruptcies.

Now consider three firms that owe each other $100 million, as shown in Figure 1. Assume each firm needs to receive payment prior to paying its obligations due to funding levels. That is, Firm A needs $100 million from Firm B to pay Firm C, which owes $100 million to Firm B. Firm C needs the money from Firm A to pay Firm B. Because each firm owes a different firm, these trades cannot easily be closed out promptly.

Compressing these positions one by one is difficult as everyone wants their money first, inducing gridlock. The clearinghouse offers an elegant solution by simultaneously managing multilateral obligations, balancing claims and assets. Because the clearinghouse provides certainty and liquidity obligations, no financial firm has to consider whether it will receive its payments prior to paying its own obligations.

Figure 1: Triangular Problem



In Figure 1, netting has provided economic efficiency, but it has not necessarily reduced systemic risk. Consider a scenario where a fourth systemically important firm is owed a large amount of capital by one of the clearinghouse members. If this transaction occurs outside the clearinghouse (e.g., fourth firm is not a clearinghouse member), then the presence of a clearinghouse actually increases this firm's risk.

Contagion and Systemic Risk

LO 69.2: Analyze the role of clearinghouses in reducing contagion and systemic risk in financial markets.

As mentioned earlier, if a large financial institution fails to meet its obligations to another institution, its failure could be contagious, spreading through the financial system. The result of this singular action could cause a group of financial institutions to collapse similar to a row of dominoes collapsing due to the tipping over of the first domino.

However, if regulators provide additional support to one of the early dominoes (i.e., institutions) before contagion causes the collapse of the entire row, the benefits are enormous. After the 2007–2009 financial crisis, clearinghouses' potential power to reduce systemic risk came to the forefront. That is, regulators believed if risky trades utilized a clearinghouse, contagion could be stopped. A large institution could still collapse, but the clearinghouse would stop its failure from spreading to inter-connected institutions.

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The **Dodd-Frank Act** is expected to move trillions of dollars in derivatives trading into clearinghouses, and these clearinghouses are expected to provide the market and its participants protection from systemic risk. However, there is a real possibility that the ability of clearinghouses to contain financial contagion is actually overstated.

Clearinghouses can only marginally lower systemic risk for the following two reasons:

1. A clearinghouse is unable to contain the systemic risk of financial contagion from an undercollateralized counterparty's failure because it cannot eliminate the targeted loss from the economy. Instead, the clearinghouse can only transfer the risk of loss to a different location in the system. As long as risks land in systemically important markets and institutions, the systemic benefit of the clearinghouse is reduced or even eliminated by its cost. Risk and loss transfer can easily end up in another systemically dangerous spot.

   The reasoning behind the need for a clearinghouse by regulators and legislators is that some institutions should not be allowed to fail due to the extent of their systemic connections. However, the presence of a clearinghouse may result in default becoming more acceptable and, therefore, more frequent.

2. The clearinghouse is defenseless against other potent channels of systemic risk beyond the failure of a vital stand-alone financial institution. Congress and regulators have previously failed to compare the benefits of a clearinghouse relative to the core problems of the financial crisis. A clearinghouse is meant to prevent a single firm's failure from spreading to other connected firms, but the recent crisis involved the simultaneous failure of multiple firms. As prices deteriorated, firms could not determine counterparty solvency. As a result, they ceased trading and panic ensured.

To better understand why a clearinghouse is not a perfect solution to the issues experienced during the recent financial crisis, it's beneficial to look at the following list of things that a clearinghouse cannot do.

Eliminating Risks with Collateral Collection

Relative to the derivatives market, the clearinghouse will more effectively collect collateral from traders by using a collateral requirement formula. While requiring its members to post collateral reduces the clearinghouse's exposure, it raises the exposure of the firms that conduct non-clearinghouse transactions with clearinghouse member firms. That is, the collateral used for the clearinghouse is not available to the firm's other creditors.

Reducing Risks with Complex Setoff

In a complex setoff, a creditor can set off (i.e., net) a debt it owes to a company with a payment due from the firm. Settling mutual debts in a single transaction is efficient. However, if one of the parties is bankrupt, it does not actually reduce the loss. Instead, the setoff redistributes losses by settling the claims between the two parties pre-bankruptcy before other parties. Doing so with a clearinghouse would lead to the same result, and it is unclear whether basic risk transfer can halt systemic risk.

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Risk Transfer

Continuing with the netting example from the previous LO, let's look at how both the absence and presence of a clearinghouse and setoff can affect risk.

Without setoff, without a clearinghouse: The failure of one institution to meet its obligation can sink a creditor institution. Consider a triangle scenario where Firm A owes Firm B $100 million and Firm B owes Firm C $100 million. If Firm B experiences financial difficulties, it may be unable to pay Firm C. In the event Firm B receives payment from Firm A, it may choose to pay other creditors rather than Firm C.

With setoff, without a clearinghouse: Monies due to the creditor are offset by monies due to the debtor from the same creditor. Setoff is achieved, but no risk transfer occurs. Consider a scenario where Firm A and Firm B owe each other $100 million. If either firm experiences financial difficulty, the other firm is not affected as it can set off the amount owed with the amount due.

With setoff, with a clearinghouse: Consider again the triangle scenario where Firm A owes Firm B $100 million and Firm B owes Firm C $100 million, except in this situation all payments due are sent to the clearinghouse, which then pays the recipients. If Firm B experiences financial difficulties, the clearinghouse can use the payment from Firm A to pay Firm C, and Firm B neither receives its $100 million nor pays its $100 million. If the impact of Firm B's failure stopped at this point, the clearinghouse would have reduced systemic risk and it was likely worth the regulatory efforts to construct the clearinghouse.

Clearinghouse transmits inside loss to the outside: Next, let's examine a scenario with a non-clearinghouse firm (Firm D) and three clearinghouse members (Firms A, B, and C). Assume Firm B owes $100 million each to Firm C (clearinghouse transaction) and Firm D (non-clearinghouse transaction) and is owed $100 million from Firm A (clearinghouse transaction). If Firm A collapses, the clearinghouse will still ensure that Firm B receives its payment. However, it will also require that this payment be used to pay Firm C rather than Firm D. As a result, the clearinghouse has transferred the risk and loss of Firm A's collapse outside of the clearinghouse system.

Modigliani-Miller Irrelevance Propositions

As mentioned, clearinghouse members can benefit from reduced risk. However, the overall impact on systemic risk is dependent on the institutions that benefit and are harmed by the risk transfer. In the above scenario, if Firm D was in better (worse) financial health and less systemically important than Firm C, systemic risk would likely decrease (increase). Therefore, the observation that clearinghouses reduce systemic risk is only true if certain criteria are met.

Classical financial theory suggests that an optimal corporate debt level would reduce capital cost because debt reduces risk. Corporate debt was previously considered safe and cheap thus accruing benefits to the firm. Later work showed that capital market inefficiencies could create (or destroy) firm value as information inside and outside a firm differ, and debt can mitigate these inefficiencies better than equity.

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Modigliani and Miller disproved this risk-reduction wisdom and illustrated that the firm's operations (not its debt/equity structure) determine its overall risk level. Adjusting its debt level transfers risk between debt and equity, but does not mitigate the business's underlying risks.

The clearinghouse-setoff analysis is parallel to the debt/equity concept. The clearinghouse cannot reduce or eliminate the systemic risk or contagion resulting from the collapse of a firm. Instead, the clearinghouse provides risk transfer by moving the loss to other non-clearinghouse creditors, without changing the financial system's overall value. Therefore, systemic risk is reduced if and only if the other creditors are systemically unimportant, financially stronger, or better able to adjust to risks.

Too-Big-To-Fail Clearinghouses

LO 69.3: Apply the concept of "too big to fail" to the use of clearinghouses.

Due to the trillions of dollars flowing through them, clearinghouses will themselves likely become too-big-to-fail institutions. The failure of a clearinghouse or rumors of its weakness is a source of systemic danger. The best-case scenario is that clearinghouses have a lower probability of failure than their constituent financial institutions.

Proponents of clearinghouses point out that no American financial clearinghouse has collapsed in modern times. However, this neglects past bailouts (e.g., in 1987, the Chicago Mercantile Exchange received a $400 million bailout three minutes before market open).

Clearinghouse Shortcomings

LO 69.4: Evaluate the shortcomings of clearinghouses in reducing risk.

As mentioned, clearinghouses are not effective at reducing overall systemic risk, but instead mostly transfer risk. Eradicating risk between two parties can mistakenly be thought to eliminate systemic risk, when in reality that risk is only transferred to a third party.

Although a clearinghouse may appear to be a formidable direct barrier to systemic risk, financial panic will likely find a bypass around the barrier and systemic risk will reappear in a different location of the financial system. While the clearinghouse structure would contain the risk of a singular institution's failure dragging down its financial counterparties, it is unlikely to be able to handle the major financial debilities of the recent financial crisis.

The 2007–2009 financial crisis stemmed from widespread overallocation to mortgage securities, which experienced a sudden and dramatic drop in value. This negatively impacted many major financial firms concurrently. As multiple institutions rushed to sell mortgage securities and other assets, prices were pressured further downward, threatening other institutions.

Regulators are reconsidering the effect of clearinghouses on financial systems. Additional attention is being considered that clearinghouses will become too big to fail. However,

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proponents of the clearinghouse structure contend that a clearinghouse has a lower probability of failure than the old system. However, the regulatory balance here (too big to fail vs. lower probability of failure) is not the correct comparison to utilize. The primary advantage of the clearinghouse structure is strong collateral collection, assisted by a complex setoff structure. However, such structures are well known in bankruptcy as only transferring losses to outsiders and being ineffective at reducing risk. Furthermore, each clearinghouse benefit is offset by an underrated or unconsidered cost, summarized as follows:

1. Collateral given to the clearinghouse is unavailable to other trading partners.
2. Counterparty risk reduction is often offset by risk transfer to vital outside institutions.
3. Mutualization benefits are offset by the potential to funnel distinct moderate-level risks into a concentrated area resulting in substantial systemic danger.
4. Transparency in ensuring completed trades can become panic-driving opacity when clearinghouse solvency depends on a successful capital call from an unstable member.
5. Speed in settling some transactions may be partly offset by slowed settling of other non-clearinghouse transactions.

The notion that panic can be avoided by shifting losses from a financial firm to a clearinghouse ignores a key fact. Similar to a systemically important institution, a clearinghouse will be systemically interconnected with the financial system. For example, consider that the risk driver is, as it was in 2007–2009, that multiple financial institutions suffered major losses in the same sector. In this case, the notion that panic can be avoided by shifting the location of the loss to a different location in the financial system may end up being wishful thinking.

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Key Concepts

LO 69.1

There are five key advantages of clearinghouses with respect to derivatives:

1. Standardization and improved price transparency.
2. Centralization of counterparty risk.
3. Centralization of collateral collection.
4. Mutualization of risk.
5. Netting.

LO 69.2

The clearinghouse cannot reduce or eliminate the systemic risk or contagion stemming from the collapse of a firm. Instead, the clearinghouse provides risk transfer by moving the loss to other non-clearinghouse creditors, without changing the financial system's overall value. Therefore, systemic risk is reduced if and only if the other creditors are systemically unimportant, financially healthier, or more suited to adjust to risks.

LO 69.3

Due to the size of the derivatives market, clearinghouses will quickly become too-big-to-fail institutions. The failure or rumored trouble of a clearinghouse would contribute to systemic risk. In the best-case scenario, a clearinghouse has a lower probability of collapse than their constituent financial institutions.

LO 69.4

Benefits associated with clearinghouses are offset by an underrated or unconsidered cost as follows:

1. Collateral given to the clearinghouse is unavailable to other trading partners.
2. Counterparty risk reduction is often offset by risk transfer to vital outside institutions.
3. Mutualization benefits are offset by the potential to funnel distinct moderate-level risks into a concentrated area resulting in substantial systemic danger.
4. Transparency in ensuring completed trades can become panic-driving opacity when clearinghouse solvency depends on a successful capital call from an unstable member.
5. Speed in settling some transactions may be partly offset by slowed settling of other non-clearinghouse transactions.

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Concept Checkers

1. Which of the following actions is not an example of a clearinghouse advantage?
   A. Improve trading efficiencies.
   B. Compress complex trading obligations into simpler obligations.
   C. Speed up settlements.
   D. Prevent financial contagion.

2. Which of the following statements regarding clearinghouses and their ability to lower systemic risk is true?
   I. A clearinghouse cannot remove the loss from the economy, but only transfers the loss elsewhere.
   II. Clearinghouses are often defenseless against other sources of systemic risk beyond the failure of a vital singular financial institution.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

3. How does the too big to fail concept most likely apply to a clearinghouse structure?
   A. Clearinghouses themselves may become too-big-to-fail institutions.
   B. By using a clearinghouse structure, no singular institution can become too big to fail.
   C. The collateral required by the clearinghouse ensures that institutions are no longer able to collapse.
   D. Unlike other institutions, the potential failure of a clearinghouse does not influence the level of systemic risk.

4. Which of the following statements is incorrect regarding the clearinghouse's ability to reduce risk?
   A. Clearinghouses primarily transfer risk rather than eliminate risk.
   B. Eliminating risk between two parties only transfers it to a third party.
   C. Clearinghouses can most likely handle a major stand-alone failure.
   D. Clearinghouses can handle a crisis stemming by a system-wide overinvestment in a large market, such as mortgage securities.

5. Strong collateral collection is a benefit of clearinghouses, but this is offset by which of the following costs?
   I. Collateral given to the clearinghouse is unavailable to other creditors.
   II. Counterparty risk reduction is often offset by risk transfer to vital outside institutions.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

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Concept Checker Answers

1. **D** Clearinghouses can do very little to stop financial market contagion. However, the key advantages of clearinghouses allow for more efficient trading, quicker settlements, and a simpler obligation structure.

2. **C** Both statements are true. Clearinghouses primarily transfer risk instead of reducing loss and are defenseless against other channels of systemic risk.

3. **A** Clearinghouses themselves may become too-big-to-fail institutions, and clearinghouse failure or even rumor of weakness is itself a systemic danger. The other statements are inaccurate.

4. **D** Clearinghouses transfer risk instead of reduce risk. Eliminating risk between two parties likely only transfers it to another party. Also, clearinghouses can handle a major stand-alone failure but not a substantial system-wide crisis.

5. **C** Both statements are true. Collateral given to the clearinghouse is unavailable to other trading partners, and counterparty risk reduction is often offset by risk transfer to vital outside institutions.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

High-Frequency Trading and Its Impact on Markets

Topic 70

Exam Focus

This topic describes high-frequency trading (HFT) in the context of financial markets. It explains how trading algorithms can be predatory, taking advantage of low-frequency traders (LFTs). The topic describes three such algorithms: quote stuffers, quote danglers, and pack hunters. The explosion of HFT is driven by an increase in computing capacity and speed, the ability of computers to use big data to make trading decisions, the ability of computers to read millions of webpages and translate the information into buy and sell decisions, and the ability of computers to identify exploitable patterns in trades. Regulatory solutions are still evolving and it is not clear exactly what can and/or should be done to manage the risks of HFT.

Algorithmic Trading vs. High-Frequency Trading

LO 70.1: Distinguish between algorithmic trading and high frequency trading (HFT).

The bulk of trading in the United States and worldwide is now **high-frequency trading** (HFT). HFT is computer-determined trading. It is a computer program that buys and sells with the smallest possible delay, called latency. It is, as the name implies, about speed, but that is not all. There is a new trading paradigm. Many aspects of the market that participants have relied on for decades have shifted. High-frequency traders (HFTs) use super-high-speed computers to trade. The computers are looking for predictable patterns from which they can profit. Even, for example, investors buying and selling in round lots. Humans think in terms of 5, 10, 100, 1,000, and so on. Computers do not think in round numbers. As such, a computer can "see" little things like a trader buying in round lots and attempt to profit from that action. HFT reduces spreads because it engages in intermarket arbitrage, buying in one market and selling in another. HFT moves liquidity from where it is abundant to where it is less plentiful. As such, two of the main benefits of HFT often cited are reduced spreads and increased liquidity.

Because milliseconds matter in the HFT world, firms co-locate servers so they are nearer to the matching engines of exchanges. High-speed computers predict relationships between securities and calculate variances and covariances between securities. For example, when one stock goes up, the computer calculates the probability, based on predicted correlations, that others will also increase. It trades the stock(s) that are expected to increase in split seconds. However, HFT is not necessarily predatory, as some think.

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Humans think not only in round numbers, but also in terms of time. When an order is sent to a broker, he often splits it up and trades the pieces based on the clock (e.g., selling 1,500 shares at the beginning of each hour for six hours). The computer, on the other hand, does not think like a clock, it thinks more in terms of the amount of volume. It takes longer, for example, to trade several hundred thousand futures contracts in the middle of the night, when volume is low, than in the middle of the day, when volume is higher. The shift here is that the computer thinks in terms of a "volume clock" rather than a time clock and trades accordingly.

One of the "bad" aspects of HFT is that it can use predatory algorithms. **Algorithmic trading**, as described in this topic, has a predatory nature. Some HFTs engage in sequential games to take advantage of **low-frequency traders** (LFTs). In some cases, these algorithms can produce a foreseeable outcome, which the computer can then exploit. Three examples of predatory algorithms are as follows:

1. **Quote stuffers**. The goal of a quote stuffer algorithm is to slow down competing algorithms. It literally floods an exchange with messages. Messages communicate orders, cancellations of orders, confirmations, and so on.

2. **Quote danglers**. The goal of quote dangler algorithms is to confuse or muddy the quote process. Orders are entered and instantly canceled thousands of times, but the computer never actually trades. The aim is to convince another computer to raise (or lower) its bid on apparent (but not real) volume. If the computer takes the bait and raises (or lowers) the bid, the quote dangler sells (or buys) at a profit.

3. **Pack hunters.** Here, HFTs become aware of each other's independent actions. For example, they join forces to maximize the chance of causing an instrument's price to fall. The pack joins forces to push the price, moving the quote down in this example, until it identifies the stop-loss price (i.e., stop hunting). Once the stop loss orders are triggered, there is a sell-off, causing the price to fall. The HFTs then buy the instruments and ride the price back up.

LFTs must be able to find liquidity without leaving a footprint. LFTs must learn to trade periods when there is more volume and they are less detectible. They must also avoid telltale signs like round numbers when they trade. LFTs must be invisible to HFTs.

Professor's Note: The phrases algorithmic trading and high-frequency trading are often used synonymously. However, in this learning objective, a distinction is made between algorithmic trading and HFT. In this topic, algorithmic trading is used to describe the potential predatory behavior of computers trading, but not all HFT is predatory by nature. However, HFT uses algorithms.

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The Evolution of HFT

LO 70.2: Identify factors that drove the evolution of HFT.

Several factors have driven the evolution of HFT, including:

- Available **computing power**. Super-high-speed computers and electronic execution make HFT possible.
- **Big data**. Some traders have a distinct advantage over others in terms of information. HFTs look at "level 3" quotes, which is the highest level of access afforded to market makers. HFTs use order book depth to figure out where their orders are going to be. They use their understanding of how the exchange matching engines work, and estimate other market participants' liquidity needs. As an example, on April 23, 2013, a hacker tweeted on the Associated Press Twitter account stating that President Obama had been hurt in an explosion at the White House. The tweet was immediately translated into a sell signal and the market dropped more than 140 points in a matter of minutes. The story was false and the market recovered almost instantly. This is an extreme example of the effects of trading on big data.
- **Natural language programming** (**NLP**). HFTs are able to read millions of webpages using NLP, allowing them to trade on the basis of new fundamental information. HFTs digest the information from the webpages and generate a statistic that translates into a buy or sell. Some firms are developing market sentiment indices using this information. Watson, IBM's supercomputer that played on *Jeopardy*, now works for hedge funds, deciding how to trade on information gleaned from reading millions of webpages.
- **Ability to identify patterns**. HFTs can easily detect LFT's trading behaviors using algorithms. LFTs are called GUI traders because they are human and use a graphical user interface. As noted earlier, humans like round numbers. HFTs know this and exploit it. LFTs often trade in predictable time patterns as well. For example, LFTs that trade at the beginning of each hour can be detected and exploited by HFTs.

HFT Impact on Regulation

LO 70.3: Discuss the implications of HFT on regulation in financial markets.

Policymakers and regulators must decide whether to impose restrictions on HFTs. Circuit breakers, put in place to protect against market crashes, halt trading after the market has fallen by a certain percentage. The problem, however, is that the market has to fall dramatically before the circuit breaker is activated. In an HFT world, regulators need solutions that will prevent the market from falling apart in the first place, not after the damage is done. For example, the Chicago Mercantile Exchange (CME) has something called "stop logic," which looks at all the orders in its books and assesses the impact if the orders are executed. Stop logic stopped the "flash crash" of 2010. It predicted the market could plunge and stopped trading (i.e., closed the market) to prevent it.

In a high-speed trading world, regulations need to be preemptive, not reactionary. Restrictions need to be executed in advance of a crash, not following one. This means regulators need tools to help them predict potential problems. Easley, Hvidkjaer, and O'Hara (2002) developed the idea of PIN or the probability of informed trading. In market microstructure studies, researchers argue that the bid-ask spread reflects risk, specifically the

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risk of trading with someone who knows more than you, called an **informed trader.** This model is difficult to estimate in an HFT world though.

Easley, Lopez de Prado, and O'Hara (2012)[1] have proposed a new, similar idea called the VPIN or volume synchronized probability of informed trading. This model allows researchers and potentially regulators, to estimate the toxicity in the market by examining the imbalance between buy initiated volume and sell initiated volume. People with new information cannot profit from it without trading on it. The authors show that the VPIN, and the cumulative distribution function of the VPIN, captured the buildup in toxicity before the flash crash of May 6, 2010. They suggest that regulators will need predictive tools like the VPIN to manage HFT in the future.

In Europe, there is a proposal for a transaction tax that is expected to slow down the speed of trading. However, a tax will make markets less attractive to HFTs and maybe to all traders because it will reduce liquidity. The United States and England are not expected to follow suit. France and Italy have imposed a tax and have seen volume drop in their markets by 20%.

Futures markets have fees for excessive order cancellations, but equity markets generally do not. In most cases, cancelled orders are not problems in and of themselves. For example, an algorithm puts orders into multiple exchanges or venues, looking for liquidity. When it cannot find the liquidity, the algorithm cancels the orders. Thus, canceling large numbers of orders is not evil per se. Message caps have been implemented, although, because message levels are so excessive in both futures and equity markets (i.e., derivative and equity orders are often placed and canceled), the caps are set so high, they are rarely breached.

In sum, the risks are different in a high-speed world. As such, the risk management tools must also be different. Policymakers and regulators are still trying to figure out what types of constraints need to be in place.

Liquidity Risk vs. Timing Risk

LO 70.4: Distinguish between liquidity and timing risk.

The difference between the decision price (i.e., the price at which the trader decides to buy or sell) and the final execution price, which includes taxes, transaction costs, and so on, contains two components, a *timing* component and a *liquidity* component. When a trader wants to execute immediately, liquidity costs will be high. If the trader can wait, liquidity costs will be lower but timing risk will increase (i.e., the price of the asset can move in an unfavorable direction). The trader is, therefore, trying to find the point where liquidity and timing risks are minimized.

For example, assume that the market is overrun with traders wanting to sell a stock. An investor who wants to buy faces low liquidity risk and low liquidity costs. However, a trader who wants to sell in the same market will face high liquidity risk and high liquidity costs (i.e., the trader is trying to take liquidity from a market that does not have liquidity). If the trader who wants to sell waits, liquidity costs will decline but the price may also decline.

1 David Easley, Marcos M. de Prado, and Maureen O'Hara. "Flow Toxicity and Liquidity in a High Frequency World," *Review of Financial Studies*, 25, 5 (2012): 1457–1493.

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Key Concepts

LO 70.1

HFT is computer determined trading. It is a computer program that buys and sells with the smallest possible delay. One of the "bad" aspects of HFT is that it can use predatory algorithms. Some HFTs engage in sequential games that can be used to take advantage of LFTs and possibly other HFTs. In some cases, these algorithms can produce a foreseeable outcome, which the computer can then exploit. Quote stuffers, quote danglers, and pack hunters are examples of predatory algorithms.

LO 70.2

Several factors have driven the evolution of HFT. First, super-high-speed computers and electronic execution make HFT possible. Second, supercomputers are able to use big data to gain a competitive advantage in trading. Third, HFTs are able to read millions of webpages using natural language programming (NLP), allowing them to trade on the basis of new, fundamental information. Also, HFTs can easily detect LFTs trading behaviors using algorithms, allowing them to take advantage of LFTs.

LO 70.3

Policymakers must decide how to constrain the behavior of HFTs. Circuit breakers are currently in place in some markets but they suspend trading following a large decline. Regulations need to prevent the decline in the first place. Fees have been proposed in some countries that are intended to slow down trading. However, the U.S. has not adopted these measures. Futures exchanges impose fines on firms for excessive messages (e.g., large volumes of canceled orders). There are also message caps in place in some cases. The risks are different in a high speed world, so risk managers and policymakers must adapt. The discussion regarding the appropriate ways to regulate HFTs is ongoing.

LO 70.4

The difference between the decision price and the final execution price of a trade is made up of two components, a timing component and a liquidity component. When a trader wants to execute immediately, liquidity costs will be high. If the trader can wait, liquidity costs will be lower but timing risk will increase (i.e., the price of the asset can move in an unfavorable direction).

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Concept Checkers

1. A high-frequency futures trading firm is fined for sending an excessive amount of messages to the exchange. The firm was likely running an algorithm called a:
   A. quote dangler algorithm.
   B. non-matching engine algorithm.
   C. quote stuffer algorithm.
   D. latency arbitrage algorithm.

2. Which of the following statements is most likely correct? High-frequency trading:
   A. is predatory.
   B. is not predatory.
   C. may be predatory.
   D. is prohibited by regulation from being predatory.

3. Which of the following statements is most accurate? Computers are able to read millions of webpages and trade on the information gleaned from those pages via:
   A. PINs.
   B. big data.
   C. the Freedom of Information Act.
   D. natural language programming.

4. Quinn Fisher, a mathematician and computer programmer, is working on a program that will allow an exchange to look at all orders in the order book and anticipate the effect on the market if the orders are executed. Fisher believes that to protect the marketplace from rogue high-frequency traders and from mistakes, firms must have the tools to stop problem trading before it happens. The Chicago Mercantile Exchange has the technology to do what Fisher is attempting, and it is called:
   A. stop logic.
   B. stop loss technology.
   C. volume deactivation technology.
   C. order book assessment technology.

5. The risk that an instrument's price will adversely change in the time it takes a trade to execute is called:
   A. liquidity risk.
   B. timing risk.
   C. execution risk.
   D. fundamental risk.

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Concept Checker Answers

1. **C** One of the "bad" aspects of HFT is that predatory algorithms can be deployed. Three examples of predatory algorithms are quote stuffers, quote danglers, and pack hunters. The goal of a quote stuffer algorithm is to slow down competing algorithms. It literally floods an exchange with messages.

2. **C** HFT is not necessarily predatory, although it may be. However, there are algorithms specifically designed to cause a reaction in the market that can be exploited. For example, quote stuffers are designed to slow down competitors. Also, quote danglers attempt to trick competitors into raising or lowering their bids or asks based on perceived volume.

3. **D** HFTs are able to read millions of webpages using natural language programming (NLP), allowing them to trade on the basis of new fundamental information. HFTs digest the information from webpages and generate a statistic that translates into a buy or sell order.

4. **A** In an HFT world, regulators need solutions that will prevent the market from falling apart in the first place, not after the damage is done (e.g., circuit breakers). The CME has something called "stop logic," which looks at all the orders in its books and assesses the impact if the orders are executed. Stop logic stopped the "flash crash" of 2010. It predicted the market could plunge and stopped trading (i.e., closed the market) to prevent it.

5. **B** The difference between the decision price and the final execution price of a trade is made up of two components, a timing component and a liquidity component. When a trader wants to execute immediately, liquidity costs will be high. If the trader can wait, liquidity costs will be lower but timing risk will increase (i.e., the price of the asset can move in an unfavorable direction).

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Controlling Risk in a Lightning-Speed Trading Environment

Topic 71

Exam Focus

This topic discusses the importance of speed to high-frequency trading, the advantages and disadvantages of speed, and ways market participants can increase trading speed. For the exam, understand why and how firms continue to shave off milliseconds of delay to speed up trading. Also, understand the pre-trade and post-trade risk controls that clearinghouses impose on members.

High-frequency algorithmic trading takes advantage of advances in technology, mathematics, and high-speed communications to allow firms to trade in fractions of seconds. Computerized quantitative models are used to identify buy and sell opportunities in stocks, futures, and options. Models also identify price, quantity, timing, and the optimal location of trades. Sometimes called **black boxes**, these systems read market data and transmit thousands of messages per second to exchanges to place, cancel, and replace orders based on market conditions. With virtually no human intervention, these black boxes are able to identify and capitalize on price discrepancies in the market. Algorithmic trading in U.S. equities markets grew from approximately 30% of total volume in 2005 to approximately 70% by 2009. A mere 2% of the 20,000 U.S. equity trading firms initiated these transactions.

Importance of Speed to HFT

LO 71.1: Explain the importance of speed to high frequency trading.

Financial securities are volatile, and traders who wish to buy or sell are exposed to market risk in the time it takes an order to be filled. The faster one is able to act (e.g., buy a stock), the less likely the price of the stock will move up before the order is filled. Traders want to fill orders before the price of the asset moves in the opposite direction of the strategy. This is why absolute speed is important. Relative speed is also important. If one trader/firm/computer can act faster than another, there are profit opportunities available.

In the world of **high-frequency trading** (HFT), the concept of latency is important. **Latency** (or delay) is the time it takes a person or computer to recognize an event, like a change in the bid-ask spread, act on the information, and have the exchange respond. For example, a trader sees that the bid-ask spread has widened, she places a sell order based on the information, and the exchange fills the order. The trader who can complete the cycle with the least delay has an advantage. Latency is measured in microseconds or one millionth of a second. For comparison, it takes humans about 400 to 500 milliseconds (one thousandth of a second) to recognize and respond to things they see.

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High-frequency traders (HFTs) send orders to the **exchange matching engine**, a computer that operates on an order book, matching and executing orders. High-frequency traders want their orders executed first. Reducing latency, even by millionths of seconds, allows high-frequency traders to execute orders at lightning speed and "beat" the competition.

Additionally, some customers of clearing members and some nonclearing members send their orders directly to exchanges to increase speed of trade executions. This is discussed in more detail in the next LO.

Methods to Speed Up Trading

LO 71.2: Describe ways in which market participants can speed up their trading.

Exchange clearinghouse members are known as **clearing members.** Clearinghouses match and settle trades. Clearing members are called **broker-dealers** in the securities markets, and they are referred to as **futures commission merchants** (FCMs) in the futures markets.

Nonclearing members are not members of a clearinghouse. They must clear trades through a broker-dealer or FCM. Clearing members are monitored by clearinghouses. They are required to maintain a certain level of capital and put up margin for positions they maintain (and for their customers and nonclearing members who make trades through the clearing member). Clearing members are also required to contribute to a loss-sharing pool. In essence, the clearinghouse attempts to mitigate the credit risk imposed by members, and clearing members must monitor customers and nonmembers to protect against risks they pose to the clearing members.

As a means of reducing latency (i.e., increasing speed), nonclearing members and clearing members' customers can now send trades directly to exchanges via their own vendor-provided trading platforms. This is done in one of the following two ways:

1. **Sponsored access.** Sponsored access has some built in pre-trade risk controls, unlike unfiltered sponsored access.

2. **Unfiltered sponsored access.** Unfiltered sponsored access is known as naked access in equity markets and direct market access in futures markets.

Nonclearing members and customers of clearing members with sponsored access are allowed to send orders to the exchange matching engine directly. Sponsored access imposes pre-trade risk controls on traders, such as limits on execution prices and order quantities.

Unfiltered sponsored access provides firms with direct access to exchanges without risk checks. With naked access, there are no pre-trade risk controls. Trades are sent directly to the matching engine without any price or quantity limits. HFTs prefer unfiltered sponsored access because it is faster. Pre-trade risk controls increase latency (i.e., slow down trades).

Firms have found another way to reduce latency by moving their servers closer to the exchange matching engine. The closer the server is to the exchange matching engine, the quicker the trade. It is estimated that every 100 miles equates to a one-millisecond delay in executing trades. To reduce the delay, exchanges are now offering **co-location services.** This

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service allows firms to place servers close to the exchange matching engine. The New York Stock Exchange, the Chicago Mercantile Exchange, Euronext and others offer co-location services. Locating close to the matching engine reduces latency in two ways:

1. It reduces the time it takes the computer to access the central order book. The central order book holds electronic information on current prices along with information on buy and sell quotes.

2. It reduces the time it takes to transmit trade requests and execute matched trades.

In sum, market participants can speed up their trading by locating close to the matching engine which may mean taking advantage of co-location services. Participants can also reduce latency by placing trades directly with the exchange using unfiltered sponsored access, which allows the firm to bypass pre-trade risk controls.

Advantages and Disadvantages of Speed

LO 71.3: List the advantages and disadvantages of speed.

The rise in high-frequency trading was spurred by the decimalization of stock prices, implemented in 2000 (i.e., stock prices quoted in pennies instead of fractions of a dollar). Smaller tick sizes caused a dramatic increase in the volume of market data. The additional information (i.e., thousands of data points per second), overwhelmed human capabilities for assimilation. However, computers were ideally suited to handle the avalanche of data.

Advantages of high-speed trading include:

- The ability of computers to assimilate mountains of data and capitalize on price discrepancies.
- Narrower spreads, which benefit investors.
- Increased liquidity, which benefits the market.
- Firms can quickly capture trading opportunities.

Disadvantages of high-speed trading include:

- Increased risks, including systemic risks, caused by co-location services, unfiltered sponsored access, and high-frequency trading. These innovations increase the speed at which fraudulent trading or trading errors can occur. In some cases, individual losses have amounted to hundreds of millions of dollars.
- Black boxes sometimes trade with other black boxes. A mistake by one firm can impact the trading strategy of another firm.
- Some regulators and other industry experts are concerned that one or more of these black boxes might "go berserk," causing enormous losses. According to one former deputy at the Securities and Exchange Commission, in the two minutes it takes for a broker-dealer to receive information on a trade executed by a firm with unfiltered access, billions of dollars of trades can take place. Examples of noteworthy errors include:
  - In 2002, a sell order was placed by a Bear Stearns trader for $4 billion instead of the intended $4 million. The Dow Jones Industrial Average (DJIA) dropped 100 points and more than $600 million traded before the error was detected.

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- In 2007, a Morgan Stanley trader entered an order to buy 100,000 shares in a system with a built-in 1000x multiplier. The order was entered as a $10.8 billion buy, instead of a $10.8 million buy. Before the order was canceled, nearly a billion dollars of stock traded hands.
- MF Global removed pre-trade risk controls to increase speed, leading to a $141.5 million loss in 2008 that resulted from a rogue futures trader.
- In 2003, a U.S. trading firm went insolvent in 16 seconds when a company employee with no familiarity with high-frequency trading switched on an algorithm. It took 47 minutes to realize the error and call the clearing bank. Neither the firm nor the clearing bank knew there was a problem during the 47-minute period.
- A programmer changed the parameters of an algorithm at Credit Suisse in 2007, resulting in 600,000 messages sent to the matching engine over a 20-minute period. The glut drastically slowed message traffic at the New York Stock Exchange (NYSE). Credit Suisse was fined for the incident.

Pre-Trade and Post-Trade Risk Controls

LO 71.4: Describe pre-trade and post-trade risk controls used in the marketplace.

The goal of **pre-trade risk controls** is to limit or prevent losses. Pre-trade risk controls include:

- Volume (quantity) controls that stop trades that exceed a certain size.
- Price limits that stop trades that are outside a predetermined price range.
- Trade bust policies that cancel obviously incorrect or erroneous orders.
- Risk controls imposed by clearinghouses, such as capital requirements.
- Broker-dealers and FCMs verify risk controls of customers and nonclearing members.

Post-trade risk controls include:

- Some clearinghouses, like the Chicago Mercantile Exchange, provide FCMs near real-time information on their customers' trades so that they can act in the event of error or fraud. FCMs can use the information to determine whether to allow customers and nonclearing members with unfiltered sponsored access to continue trading.
- Some, but not all, exchanges provide clearing members the means to automatically stop trades. This risk mitigation tool is important and needs to be implemented across exchanges so that trading can be halted quickly in the face of a significant error.

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Key Concepts

LO 71.1

High-frequency trading firms use computerized quantitative models to identify buy and sell opportunities in stocks, futures, and options. Latency (or delay) is the time it takes a person or computer to recognize an event, act on the information, and have the exchange respond. Firms that engage in high-frequency trading constantly pursue ways to reduce latency and increase speed. Traders want to fill orders before the price of an asset moves in the opposite direction of the strategy. Additionally, if one trader/firm/computer can act faster than another, there are profit opportunities available.

LO 71.2

High-frequency trading firms can increase speed by locating close to the exchange matching engine. One way to do this is by taking advantage of co-location services offered by exchanges. Participants can also reduce latency by placing trades directly with an exchange, using unfiltered sponsored access, which allows the firm to bypass pre-trade risk controls.

LO 71.3

Advantages of high-speed trading are numerous. Computers are able to assimilate mountains of data and capitalize on price discrepancies, making high-frequency trading possible. High-frequency trading tends to narrow spreads, which benefit investors, and increases liquidity, which benefits the market. Also, firms can quickly act on trading opportunities.

The primary disadvantage of high-speed trading is increased risk. Increased risks, including systemic risks, are facilitated by co-location capabilities, unfiltered sponsored access, and high-frequency trading. These innovations increase the speed at which fraudulent trading or trading errors can occur. Also, black boxes (i.e., high-frequency trading algorithms) sometimes trade with other black boxes. A mistake by one firm can impact the trading strategy of another firm.

In addition, some regulators and other industry experts are concerned that one or more of these black boxes might “go berserk,” causing enormous losses.

LO 71.4

The goal of pre-trade risk controls is to limit or prevent losses. Pre-trade risk controls include controls on volume and prices, preventing trades from occurring outside certain price and size limits. Trade bust policies that cancel obviously incorrect or erroneous orders are used by some firms. Clearinghouses impose risk controls, such as capital requirements, on members. Post-trade risk controls include exchanges providing FCMs with near real-time information on their customers’ trades so that they can act in the event of error or fraud. FCMs can use the information to determine whether to allow customers and nonclearing members with unfiltered access to continue trading.

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Concept Checkers

1. Which of the following statements is correct? Latency is measured in:
   A. nanoseconds.
   B. milliseconds.
   C. microseconds.
   D. seconds.

2. Keiren Kingsley, a partner at a high-speed futures trading firm, has decided, along with the firm's board of directors, to relocate the company's headquarters from Seattle, WA, to downtown Chicago, IL, to be closer to the Chicago Mercantile Exchange (CME). The firm is most likely doing this because managers want to:
   A. reduce latency.
   B. reduce taxes.
   C. forge better relationships with the upper management of the CME.
   D. comply with laws requiring nonclearing members to maintain offices in the state in which it does most of its trading.

3. Hopkins, Inc., a high-frequency trading firm, is able to place orders directly with the New York Stock Exchange (NYSE) with no constraints on the size of the trades or the prices at which the orders may be placed. Hopkins is most likely a:
   A. broker-dealer.
   B. clearinghouse member.
   C. specialist on the floor of the NYSE.
   D. firm with unfiltered sponsored access.

4. Proponents of high-frequency trading maintain that there are many advantages to quantitative, algorithmic trading. Which of the following is not an advantage of high-frequency trading?
   A. Narrows spreads.
   B. Increases liquidity.
   C. Reduces systemic risks in the market.
   D. Allows firms to quickly capitalize on price discrepancies.

5. Some exchanges have risk measures in place that automatically cancel orders that are obviously erroneous. These measures are called:
   A. stop loss orders.
   B. trade bust policies.
   C. circuit breakers.
   D. recalibration requirements.

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Concept Checker Answers

1. **C** Latency (or delay) is measured in microseconds, or millionths of a second. It is the time it takes a person or computer to recognize an event, act on the information, and have the exchange respond.

2. **A** It is estimated that every 100 miles of distance between the server and the exchange matching engine, equates to a one-millisecond delay in trading. Locating close to the matching engine reduces latency in two ways. First, it reduces the time it takes the computer to access the central order book. Second, it reduces the time it takes to transmit trade requests and execute matched trades. So the likely reason the firm is moving to Chicago is to reduce latency and increase the speed of trades.

3. **D** Unfiltered sponsored access is known as naked access in equity markets and direct market access in futures markets. Unfiltered sponsored access provides firms with direct access to exchanges without pre-trade risk controls such as limits on volume and price.

4. **C** Proponents argue that high-frequency trading narrows spreads and increases liquidity. Computers are naturally suited to reading and capitalizing on the enormous amounts of market data that exists since the decimalization in 2000. However, most would argue that high-frequency trading increases risks, including systemic risks.

5. **B** The goal of pre-trade risk controls is to limit or prevent losses. Pre-trade risk controls include volume (quantity) controls that stop trades that exceed a certain size, price limits that stop trades that are outside a pre-determined price range, and trade bust policies that cancel obviously incorrect or erroneous orders.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

How Do Exchanges Control the Risks of High Speed Trading?

Topic 72

Exam Focus

This topic explains the mechanisms used by exchanges, clearing members, and market makers to control the risks of high-speed trading. Pre-trade risk controls vary. When controls are imposed by an exchange, the risk checks increase latency uniformly across firms. When controls are left to the discretion of clearing members and market makers, there is more variability. Pre-trade risk controls place limits on price and volume. Exchanges offer some risk management tools, such as the "kill button," to their clients. For the exam, know the types of pre-trade risk controls imposed by exchanges and contrast them with controls imposed by clearing members and market makers. Also, be able to explain ways in which exchanges monitor trades for abnormal behavior as well as market manipulation. Risk mitigation techniques include providing drop copies to clients, auditing clearing members' risk controls, and creating detection tools to identify market manipulation by high-speed trading firms.

Pre-Trade Risk Controls

LO 72.1: Explain the pre-trade risk controls used by exchanges.

In the financial industry, a distinction is made between high-speed traders that are designated market makers and those that are not. Market makers are regulated and have an obligation to quote both sides of the market in specific assets over a specific number of days (i.e., they are required to provide market liquidity). Registered brokers are regulated but do not have an obligation to maintain market liquidity. Some high-speed traders are not registered brokers or market makers. They are unregulated and have no obligation to provide market liquidity. Dedicated market makers are common in equity and options markets but are rare in futures markets. Futures trading firms that are neither futures commission merchants (FCMs) nor clearing members are unregulated. These distinctions are relevant in the context of pre-trade risk controls.

Pre-trade risk controls are designed to protect the market against out-of-control algorithms that may "go berserk" due to corrupt data, human errors such as a trader placing an order to buy an instrument in the billions rather than in the millions of dollars, programming errors, hardware failures, and other issues. The goal is to have checks in place that prevent problem orders from being transmitted to the exchange matching engine. While pre-trade risk controls add to latency, when done at the exchange level (rather than at the discretion of individual firms), the delay is uniform and equitable across all market participants. Pre-trade risk checks alert firms when price or volume limits are breached (risk limits may require firms to take opposite positions when limits are breached). Exchanges can stop orders by

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setting limits at the exchange level or by providing clearing members and market makers the ability to set limits for their own and their customers' orders.

Common pre-trade risk controls include:

- **Limits on the maximum order size** that can be placed. Limits can be based on product or product class, customer/clearing members, spreads, outrights, and so on.
- **Limits that restrict the number of messages** that can be sent to the exchange over a period of time. Some exchanges allow firms to buy additional message capacity.
- **Price-banding mechanisms** that only accept orders in a specific price range. Not all exchanges have price-banding mechanisms. Also, some exchanges do not reject market makers' orders that are outside the price band.
- **Stop-logic functionality** that analyzes all orders in the book and assesses the impact on the market if the orders are executed. The exchange will halt trading if it believes a domino effect is possible. For example, the Chicago Mercantile Exchange's (CME) stop-logic functionality paused trading and helped stop the "flash crash" of May 6, 2010. Three exchanges have stop-logic functionality.
- **Intraday position limits** which set maximum positions a firm can take any time during a day. Intraday position limits are supported by only one exchange and are not mandatory.
- **Credit limits** that restrict the dollar value a firm can trade. Only one exchange has credit limits. These limits do not make sense for equity and option markets because traders can trade in many venues. For example, if a firm has a huge buy order for a stock at one exchange, the exchange does not know if it has an offsetting sell order at another exchange. Thus, intraday position limits and credit limits are difficult to impose in equity and options exchanges. Firms may impose position and credit limits at the trader level.

Offerings to Help Manage Risk

LO 72.2: Describe offerings exchanges make to their clients to help manage risk.

Pre-trade risk controls applied at the clearing member/market maker level vary across firms. Some high-frequency trading firms that access exchange matching engines directly have no pre-trade risk controls (i.e., firms with unfiltered sponsored access or "naked access"). Also, competition for customers may cause some firms to forgo pre-trade risk requirements on customers that directly access markets. These firms rely on the pre-trade risk limits set by exchanges. However, as noted earlier, controls vary across exchanges. Some evidence suggests that when market makers are allowed to set limits, they set them so liberally that the effect is no limit at all.

One of the most effective risk management tools an exchange can offer its customers to manage risk is the ability to cancel a large number of orders at one time. Clearing members literally call or fax the exchange and ask that all orders be canceled from the order book. The exchange manually executes the request, which can take time. Alternatively, the exchange can provide a **kill button** to members. A kill button allows members to cancel all orders and prevent new orders from being placed. Trade restrictions can be at the firm, trader, or desk level.

Some exchanges restrict the kill button to market makers and clearing members while other exchanges offer the kill button to all market participants (i.e., trading firms that

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access the exchange directly). In some cases, the client can manually enter parameters that, when breached, will automatically trigger the kill button. One exchange is developing an application programming interface (API) that will allow clearing members to automatically cancel or modify orders.

Sometimes trading firms lose the connection between their servers and the exchange's servers. All of the exchanges offer **cancel on disconnect functionality** that allows the firm to cancel all orders in the book when the firm loses the connection with the exchange. Exchanges indicate that nearly all high-speed trading firms subscribe to cancel on disconnect. The way the exchanges offer the service varies as follows:

- Some exchanges delete all orders in the book.
- Some exchanges provide the customer with the option of selecting which orders should be canceled.
- Two exchanges allow firms to decide what will happen when cancel on disconnect is initiated. The firm can choose to cancel the orders or leave them working in the market.
- One exchange provides cancel on disconnect functionality to market makers only, requiring trading firms to call the exchange to request that orders be canceled.

Abnormal Trading and Market Manipulation

LO 72.3: Describe monitoring for and mitigation of abnormal trading and market manipulation.

All exchanges have teams dedicated to monitoring abnormal trading behaviors. **Abnormal trading** may result from out-of-control algorithms, which are extremely rare according to a staff member at one exchange (although another exchange said they happen a few times per year but are difficult to detect unless they create a significant price impact). One exchange said it had an out-of-control algorithm in 2008. The algorithm caused a firm to trade with itself 10,000 times.

Other instances of abnormal trading arise from the placement of unusual orders. For example, a trader might accidently add an extra zero to an order (called "fat fingers" in the industry), resulting in an order that is extremely large relative to historical averages. A staff member at an options exchange indicated that out-of-control algorithms and/or erroneous trades occur every day in illiquid options. Detection is a function of the impact on the market, the pattern of the error, and how long it takes a human to recognize something is awry.

Exchanges set time limits for reporting trading errors. The time frame depends on the exchange and the product but generally ranges from 8 to 30 minutes. Examples of behaviors that would trigger concern at the exchange include:

- A firm that accumulates very large positions or volumes compared to its historical norms.
- Unusual trading patterns at specific firms. Some exchanges have automated tools to detect unusual trading patterns. If detected, someone at the exchange might call the trading firm or clearing member to inquire about the unusual trading.

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Actions that are taken when an exchange identifies what it believes to be abnormal trading vary by exchange. If an exchange detects unusual behavior and/or positions that are alarmingly large, it can:

- **Bust the trade.** If the exchange busts a trade, it can break one side of a firm's hedged position. Some exchanges only bust trades that are outside an established price band.
- **Adjust the trade.** Some exchanges do not like to bust trades so they adjust the price of the order instead.
- **Honor the trade.** Some exchanges do not like to bust or adjust trades and will honor the trade, despite its unusual nature.

Risk mitigation takes many forms, including:

- **Audits of clearing member risk controls.** Clearing members are responsible for the risks of their customers' trades. As such, exchanges audit the risk controls clearing members have in place to control high-speed trading. Two exchanges outsource the audit process to the Financial Industry Regulatory Authority (FINRA).
- **Market manipulation.** Exchanges rely on both manual and automated tools to detect market manipulation. One example of market manipulation is **spoofing**, where traders place orders with no expectation of executing the orders, a strategy that tries to trick other market participants into buying or selling at artificial prices. **Layering**, another manipulative practice, involves placing a small order on one side (e.g., a buy) that the dealer intends to execute, and a series of larger orders on the other side (e.g., a sell), which he has no intention of executing, creating a false impression of liquidity, and tricking traders into trading at false prices. Equities and options trade in multiple venues. So while an exchange can detect manipulative trading behaviors in their own exchange, they cannot detect when a firm is engaging in manipulative practices across exchanges. Equity and options exchanges provide information on cross market activity to the Intermarket Surveillance Group (ISG) on a lagged (three-day) basis.
- **Drop copy.** The drop copy service facilitates real-time monitoring of trading on an exchange. The service provides, depending on the exchange, carbon copies of execution reports, details on filled trades and working orders by trading account. Firms can compare drop copies against their own trade execution records to identify discrepancies in the number of trades recorded by the exchange versus the trading platform. Some exchanges provide drop copy in near real time while others provide it at the end of the day. At this point, drop copy is not standardized across exchanges.

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Key Concepts

LO 72.1

Common pre-trade risk controls include placing limits on the price and maximum order size, restricting the number of messages a firm can transmit to the exchange, establishing price bands, intraday position limits and credit limits, and creating stop-logic functionality to halt trading in the event of a market emergency.

LO 72.2

Exchanges offer their clients several tools to help them manage risks. A kill button allows a member to cancel all orders and prevent new orders from being placed. Trade restrictions can be at the firm, trader, or desk level. Cancel on disconnect functionality allows the firm to cancel all orders in the book when the firm loses the connection with the exchange. All of the exchanges offer cancel on disconnect functionality but not all exchanges offer clients the kill button option.

LO 72.3

All exchanges have teams dedicated to monitoring abnormal trading behaviors. Teams are tasked with recognizing signs of out-of-control algorithms and obviously erroneous trades. Exchanges can honor the trade even if it is suspicious, adjust the trade by adjusting the price of the order, or bust the trade (i.e., undo the trade because of the error). To mitigate risks, exchanges audit clearing members' risk controls, provide drop copies to allow firms to compare executed orders with their own trade execution records, and monitor and stop firms that are engaging in market manipulation tactics like spoofing and layering.

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Concept Checkers

1. Which of the following statements about price bands is correct?
   A. Regulation requires exchanges to establish price bands.
   B. Some exchanges allow market makers to trade outside price bands.
   C. All exchanges have some sort of price banding mechanism in place.
   D. Price bands are no longer necessary now that firms set their own pre-trade risk controls.

2. Which of the following statements is true? Latency is:
   A. decreased by pre-trade risk controls.
   B. unaffected by pre-trade risk controls.
   C. increased by pre-trade risk controls.
   D. may be decreased or increased, depending on the implemented control.

3. Firms that have the ability to cancel all orders and prevent new orders from being placed have been provided:
   A. kill button functionality.
   B. cancel on disconnect functionality.
   C. drop order functionality.
   D. trade bust functionality.

4. When a firm places orders without ever expecting to execute the orders, just to trick competitors into buying or selling at artificial prices, it is known as:
   A. spoofing.
   B. quote stuffing.
   C. quote dangling.
   D. algorithmic trading.

5. An options exchange recently performed an audit of a clearing member's pre-trade risk controls. The controls were designed to manage risks that arise from high-frequency traders. The exchange found the controls to be insufficient. Why does the exchange care about the pre-trade risk controls imposed on the customers of clearing members?
   A. Regulation requires exchanges to audit clearing member risk controls.
   B. Exchanges are financially responsible for clearing members' customers.
   C. Exchanges are required by the Dodd-Frank Act to protect financial markets from market manipulation by high-frequency traders.
   D. Clearing members are financially responsible for their customers' trades.

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Concept Checker Answers

1. **B** Price-banding mechanisms only accept orders in a specific price range. Not all exchanges have price-banding mechanisms. Also, some exchanges do not reject market makers' orders that are outside the price band. In other words, in some instances, market makers are allowed to trade outside of established price bands.

2. **C** Imposing pre-trade risk controls increases latency. Some firms with unfiltered sponsored access directly access the market with no pre-trade risk controls, reducing latency relative to other market participants who are subject to risk checks.

3. **A** A kill button allows a member to cancel all orders and prevent new orders from being placed. Trade restrictions can be at the firm, trader, or desk level. Cancel on disconnect functionality allows the firm to cancel all orders in the book when the firm loses the connection with the exchange (i.e., the firm's server loses connection with the exchange's server).

4. **A** One example of market manipulation is spoofing, where traders place orders with no expectation of executing the orders, a strategy that tries to trick other participants into buying or selling at artificial prices.

5. **D** Because clearing members are financially responsible for their customers' trades, controlling risk is very important. As a means of monitoring and mitigating risks in the financial marketplace, exchanges audit the risk controls of clearing members.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

How Do Proprietary Trading Firms Control the Risks of High Speed Trading?

Topic 73

Exam Focus

This topic focuses on the risk management tools of proprietary trading firms. It summarizes the lifecycle of new trading strategies and describes the role of risk platforms. Pre-trade and post-trade risk controls are also discussed, as well as risk management challenges and best practices. For the exam, know the general process firms follow when developing a new trading strategy. Also, know the pre- and post-trade risk limits imposed by most firms. Finally, be able to explain best risk management practices in the industry and understand that firms must protect against operational risks by separating trading from risk management and accounting functions. Firms believe that better/more specific information about trades and quicker delivery of this information will improve risk management.

New Trading Strategies

LO 73.1: Summarize the lifecycle of a new trading strategy for a trading platform.

Proprietary trading firms trade for their own accounts using their own capital. These firms normally do not have customers. They trade on public exchanges and alternative trading systems like electronic communication networks (ECNs) and dark pools. Most proprietary trading firms trade multiple asset classes like fixed income, equities, futures, and options, in one or more geographic regions (e.g., North America, Europe, Asia). Some have a presence on exchange trading floors. Some clear their own trades, and others use clearing members to clear trades. Nine firms were interviewed, and all accessed the market directly via proprietary trading platforms, although some firms purchase platforms and software to use as a backup. Firms execute trades that are (1) fully automated, preprogrammed trades (i.e., black box) and (2) fully automated, but with some trader discretion to modify algorithms (i.e., grey box).

There are several steps in the lifecycle of a new trading strategy:

Step 1: **Develop a new trading strategy.** Traders and trading groups work with developers and IT staff to translate new trading ideas into source code. Most firms have traders that also program. The code is turned into executable programs.

Step 2: **Backtest the strategy.** Simulated trading environments used for backtesting are either built in house at the proprietary trading firm or are provided by a trading venue.

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Step 3: **Analyze the results of the backtests.** If, based on backtests, the new strategy is determined not economically viable, the strategy is either modified and retested or is terminated. If the strategy appears viable, it is tested in the market in small quantities. Generally some risk limits are set before a strategy is tested in the market.

Step 4: **Analyze the results of small quantity trading.** Again, if the results from actual trading are not viable, modify the strategy and backtest again. If it appears viable, move on to step 5.

Step 5: **Set risk limits.** At this stage, the firm sets risk limits and/or writes hard code limits in the source code.

Step 6: **Begin full trading using the strategy.** There is a formal approval process required to move a strategy from the testing stage to the production stage. Traders, the trading group, the system administrator, the chief information officer (CIO), the risk manager or risk management team, and/or the release manager may play a role in approving the new strategy. Changes to the code, risk parameters, or login credentials are logged and periodically reviewed.

Risk Management Structure

LO 73.2: Describe a firm's risk management structure and the role of risk platforms.

Risk management operations differ across firms. Some proprietary trading firms have traders and risk staff report to a single risk management officer. At other firms there is no firm-wide risk manager. Instead, every trading desk has a risk manager. Some large firms with multiple locations have a risk management group at a central location.

Firms typically build their own risk platforms although some purchase platforms to use as verification of their own proprietary platforms. **Risk platforms** check all trades before routing them to exchanges and other trading venues. Risk platforms work in near real time for electronic trades. Open outcry trades must be manually entered into the risk system at the end of each day.

Some firms use value at risk (VaR) or standardized portfolio analysis of risk (SPAN) to estimate risk exposures. Other firms use proprietary algorithms to estimate profits and losses and the amount of exposure. Firms that do not hold positions overnight typically do not use VaR or SPAN. Risk models use datasets compiled by trading firms, purchased from vendors and/or purchased from trading venues. Data can be corrupt, so firms cross check results to identify mistakes and outliers. Surprisingly, some firms are not able to calculate firm-wide portfolio risk.

Trading limits are set on the risk platform at multiple levels, including:

- Trader (i.e., account).
- Trading desk.
- Trading group.
- Trading venue.
- Product.
- Strategy.
- Overall firm level.

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The CEO and management team review risk limits, which are reviewed daily and sometimes more formally on a monthly or quarterly basis. One firm said that traders who make the most money get higher risk limits.

When risk limits are breached, the trading platform may:

- Send the trader an alert via voicemail, email, or text.
- Send an alert to risk managers.
- Stop trading completely.
- Liquidate trades.
- Require traders to take opposite positions.

LO 73.3: Explain the pre-trade and post-trade risk controls employed by trading firms.

Pre-Trade Risk Controls

Pre-trade risk controls do one or more of the following:

- Warn a firm when an order is approaching a preset risk limit.
- Once a pre-trade risk limit is breached, controls may suspend order entry.
- Pre-trade risk limits may require traders to take opposite positions when risk limits are hit or breached.
- If an out-of-control algorithm or erroneous trade is detected, the trade may be stopped before being transmitted to the trading venue. Corrupt data, hardware or software failures, programming errors, network issues, and other factors may cause an algorithm to "mess up."

Exchanges also set pre-trade risk limits. These limits may be the last lines of defense if a firm's pre-trade risk controls are weak or nonexistent. As noted in previous Current Issues in Financial Markets topics, firms with unfiltered sponsored access are able to directly access the market without any pre-trade risk controls. Exchanges may set trade limits for all market participants or provide clearing members and market makers the functionality to set limits for customers.

Proprietary trading firms may set more stringent limits than the exchange. Also, proprietary trading firms do not apply pre-trade risk limits evenly across strategies. Firms often apply fewer pre-trade risk checks to some strategies to reduce latency (delays). Proprietary trading firms identified the following pre-trade risk limits:

- Limits that set a **maximum size order**.
- **Intraday position limits**, setting maximum positions the firm can take at any point in the day. Portfolio risk may be considered in setting position limits. One firm set position limits based on the percentage of average daily volume in the asset class.
- **Credit limits** on each trading account (set by all but one firm). Credit limits restrict the dollar value each trader/account can trade. Credit limits are set based on product type, dollar value, open positions, or working orders. One firm sets credit limits for new traders and adjusts the limits based on the profit/losses of the trader's account during the day.

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- **Price band limits.** Firms compare orders against a specific price range before sending the order to the exchange matching engine. Orders outside the price band are stopped. Approximately one-half of the firms have price range limits.
- Most firms have **profit/loss limits.** Trading is halted if a limit is breached. Limits may be set per trading strategy or per order.
- Most firms **have limits on the number of orders (messages) that can be sent** to the exchange during a specific period of time (e.g., per millisecond, per second, or per minute). Exchanges have bandwidth policies. Some exchanges set limits on the number of orders that can be sent to the exchange. Also, the firm can detect if an algorithm is out of control and, as a result, may be sending too many messages to the exchange.
- One firm, intending not to trade when there is (potentially) artificial volume in the market, has **volume detecting software**. This mechanism allows the firm to avoid trading against rapid buy (or sell) then cancel before execution orders.

Post-Trade Risk Controls

Firms use information to control risks after the fact. **Drop copies**, which include trade reports and messages related to orders, are provided by exchanges and other trading venues to clearing members and high-frequency trading firms. However, the content and the timing of these reports vary. Some venues provide information on executed trades and working orders while others only provide information on executed trades. The information may be provided by account or consolidated across the trading firm. Some venues provide the information in near real time while others provide it at the end of the day. Trading desks receive the information. In some firms, risk managers and middle and back offices also receive drop copies. Firms compare their own trade information with that provided by venues to detect evidence of erroneous trades or algorithms gone awry.

Two firms indicated that busted trades resulting from out-of-control algorithms are rare. Some firms indicated that market infrastructure, not algorithms, caused the "flash crash" of 2010. Staff at one firm indicated that stop orders are "weapons of mass destruction" and should be banned. This firm indicated that they stopped trading during the flash crash, due to information asymmetry, and resumed only after it appeared that there were no new developments in the news.

Some firms said they had either had, or dealt with firms that had, an out-of-control algorithm. One firm instituted a 5–10 second delay to slow down trading when orders are filled too quickly. One firm added credit checks and "fat finger" checks to pre-trade risk limits. One firm instituted a control to track the number of sell orders sent per second in response to an algorithm that sent the sell orders but did not log the order confirmations. Typically when a firm experiences, either first hand or in trading, an out-of-control algorithm, it institutes additional checks to prevent the problem in the future.

Each trading firm interviewed had a **kill button** to stop trading in extreme circumstances. Kill buttons are typically manual. However, some firms have developed an automated kill button that stops trading under certain circumstances. Typically traders, risk managers, and/or the chief operating officer (COO) are authorized to activate the kill button. Kill buttons stop trading at one or more of the following levels:

- Trader/account.
- Trading desk.
- Product type.

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- Strategy
- Firm.
- Trading venue.

Cancel on disconnect allows a firm to cancel orders when the firm's server is disconnected from the exchange's (or other venue's) server. The connection between the firm's server and their client application is called a "heartbeat" in the industry. Connections between the firm's server and the exchange's server may be disconnected due to network disruptions, a disconnect without an authenticated signoff, or a system going down. It is possible to lose one connection (e.g., the connection between the firm's server and the client application) without losing the other connection (e.g., the connection between the firm's server and the exchange's server). Some exchanges cancel all working orders in the event of disconnection (i.e., good-til-cancel, or GTC, and good-til-date, or GTD) and some only cancel GTD orders. Firms suggested that there needs to be more standardization with respect to cancel on disconnect functionality. For example, if a connection is lost for one minute (or a number of seconds) the cancel on disconnect could be activated.

LO 73.4: Describe the key challenges and best practices in firms' risk management.

Risk Management Challenges

Proprietary trading firms were asked about the challenges they face in creating effective risk management functions. They named several areas of concern:

1. Information on over-the-counter (OTC) data is largely unavailable. Transparency is an issue. Many firms believe all trading, including OTC, should occur on public exchanges.

2. Trying to replicate events like the flash crash of May 6, 2010, using stress tests is quite challenging for firms. How do you model and test for a totally unexpected event?

3. Drop copies need to be near real time. Some Asian firms in particular do not provide clearing members with drop copies in a timely manner. This means the clearing member cannot provide trade confirmations to their customers in a reasonable time period (i.e., at some point following their own receipt of the information). Firms would also like more standardization in format and speed and, in some cases, more granularity (i.e., more detailed information by trading account, product, and so on).

4. Proprietary trading firms believe regulators should provide a risk model framework and allow firms to build their own risk management systems based on the framework. Firms do not believe regulators should prescribe vendor solutions for managing the risks of sponsored access.

5. Firms also believe they understand trading risks better than regulators. As such, best practice documents from industry firms are more desirable to proprietary trading firms than regulatory guidance. Regulators should also make rules simple, realize that a "one-size-fits-all" approach does not work, and "keep their eye on the ball," maintaining consistent focus on markets.

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6. Firms believe pre-trade risk controls should be uniformly applied by trading venues. This would level the playing field and produce the same latency for all participants.

Best Practices in Risk Management

For proprietary trading firms, operational risks are a concern. One firm described the following practices they have instituted to manage operational risks as follows:

- Risk management staff are prohibited from trading.
- Traders and trading staff do not have access to risk controls and cannot change/lift risk checks.
- Risk limits must be checked daily by the heads of each trading desk.
- Trading and risk management functions are off limits to accounting staff.
- Accounting functions are off limits to treasury staff.
- Each department reports to the CEO on a daily basis.
- The head of each trading desk signs a contract stipulating that the head of the trading desk is personally and financially responsible for losses due to breaches in risk limits. Conversely, if the breach results in a profit instead of a loss, the head of the trading desk is not allowed to share in the gains.

Another firm said cross-functional meetings to discuss risk are important because risks in proprietary trading firms are constantly changing. Risk managers, traders, developers, legal staff, and so on meet to discuss risk management issues. One firm holds cross-functional meetings daily while two others hold weekly meetings.

One firm suggested that best practice firms reconcile trading activity reports with three sources: trading venues, clearing members, and internal databases. The firm noted that discrepancies would be easier to identify with more checks. The firm also suggested that trading venues conduct risk management checks, like sending false information (e.g., acknowledging 100 messages when the firm only sent 95), to better prepare firms to recognize and handle errors and other unusual circumstances.

Clearing members must also audit the risk controls of proprietary trading firms that access markets directly. Firms indicated that these audits often occur when a new clearing relationship is established. After the initial audit when the account is opened, some firms conduct audits annually and some less frequently (even rarely). Some require screenshot images that show how risk controls function when orders are executed.

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Key Concepts

LO 73.1

There are several steps in the lifecycle of a new trading strategy. First, the firm must develop the new strategy. Traders and trading groups work with IT and software developers to translate new trading ideas into source code. Second, the firm must backtest the strategy. Third, the firm must analyze the results of the backtests. If, based on backtests, the new strategy is determined not economically viable, the strategy is either modified and retested or is terminated. If the strategy appears viable, it is tested in the market in small quantities. Fourth, if the strategy is viable and is traded in small quantities, the firm must analyze the results of the small quantity trading. Fifth, if the strategy is viable, the firm must set risk limits. At this stage, the firm sets risk limits and/or writes hard code limits in the source code. Finally, the firm will begin full trading using the strategy.

LO 73.2

Risk management operations differ across firms. Some proprietary trading firms have traders and risk management staff report to a single risk management officer. At other firms, there is no firm-wide risk manager. Instead, every trading desk has a risk manager. Some large firms with multiple locations have a risk management group at a central location. Firms typically build their own risk platforms although some purchase platforms to use as verification of their own proprietary platforms. Risk platforms check all trades before routing them to exchanges or other trading venues.

LO 73.3

Trading firms employ many pre- and post-trade risk controls. Pre-trade risk controls include:

- Limits that set a maximum size order.
- Intraday position limits, setting maximum positions the firm can take at any point in the day.
- Credit limits on each trading account. Credit limits restrict the dollar value each trader/account can trade.
- Price band limits. Firms compare orders against a specific price range before sending the order to the exchange matching engine. Orders outside the price band are stopped.
- Most firms have profit/loss limits. Trading is halted if a limit is breached.
- Most firms have limits on the number of orders (messages) that can be sent to the exchange during a specific period of time (e.g., per millisecond, per second, or per minute).

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Post-trade risk controls include:

- Drop copies: post trade information provided to firms by exchanges and other trading venues are provided to clearing members and high-frequency trading firms.
- Kill buttons: gives the firm the capability to simultaneously cancel all existing orders and to prevent the entire firm from placing any new orders. It is a fail-safe and used in extreme circumstances.
- Cancel on disconnect: allows a firm to cancel orders when the firm's server is disconnected from the exchange's (or other venue's) server or when the firm's server is disconnected from the client application.

LO 73.4

Proprietary trading firms were asked about the challenges they face in creating effective risk management functions. They named several areas of concern including the lack of information on OTC data, the difficulty of using stress tests to replicate events like the flash crash of 2010, needing more standardization and timeliness to drop copies, and the desire for pre-trade risk controls to be applied uniformly across trading firms.

Best risk management practices include separating trading from risk management, separating trading and risk management from accounting functions, preventing traders from changing risk limits, holding the head of the trading desk personally and financially responsible for breaches in risk controls, and upper management taking an active role in risk management, routinely requiring cross-functional meetings to discuss risks.

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Concept Checkers

1. If results of backtesting indicate a new strategy is not economically viable, the firm should most likely:
   A. set risk limits.
   B. begin trading using the strategy.
   C. modify the strategy and backtest again or terminate the strategy.
   D. begin trading in small quantities to confirm the results of backtests.

2. Sam Goldberg, a trader for Hidden Solutions Traders, breached one of the firm's risk limits. Which of the following actions is most likely to happen to Goldberg?
   A. He receives a text alert that the risk limit has been breached.
   B. He is fired.
   C. He is asked to write a detailed report of the reason(s) for the breach for the firm's weekly risk management report.
   D. His risk limits will be tightened in the subsequent days and weeks to punish him for the breach.

3. A report that provides proprietary trading firms with post-trade information regarding executed orders, messages about orders, and other data is called a:
   A. trade report.
   B. drop copy.
   C. daily summation report.
   D. trading platform statement.

4. Which of the following statements is a risk management best practice in place at proprietary trading firms?
   A. Allowing risk managers to trade so they can understand the challenges facing traders.
   B. Allowing traders to change risk controls when they are clearly too restrictive.
   C. Requiring that risk limits be checked daily by the heads of each trading desk.
   D. Requiring the accounting staff of the firm to report directly to the treasury staff for consistency.

5. With respect to drop copies, firms would like the information to be:
   A. delivered on a daily basis.
   B. more detailed at the trader/account level instead of at the firm level.
   C. provided only to management staff so that traders cannot put their own "spin" on the information.
   D. available to all members of the firm on a weekly basis.

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Concept Checker Answers

1. **C** In this case, the firm could either modify the strategy and backtest again or terminate the new trading strategy. There are several steps in the lifecycle of a new trading strategy:
    1. Develop a new strategy.
    2. Backtest the strategy.
    3. Analyze the results of the backtests and, if viable, begin trading in small quantities. If not economically viable, modify the strategy and backtest again.
    4. Analyze the results of the small quantity trading.
    5. If the strategy is viable, the firm must set risk limits.
    6. Begin full trading using the strategy.

2. **A** Goldberg is likely to receive a text alert informing him of the breach. When risk limits are breached, the trading platform may:
    - Send the trader an alert via voicemail, email, or text.
    - Send an alert to risk managers.
    - Stop trading completely.
    - Liquidate trades.
    - Require traders to take opposite positions.

3. **B** Drop copies, which include trade reports and messages related to orders, are provided by exchanges and other trading venues to clearing members and high-frequency trading firms.

4. **C** Risk limits must be checked daily by the heads of each trading desk. A best practice firm would not allow risk managers to trade nor would it allow traders to change risk limits. Finally, accounting functions should be off limits to treasury staff.

5. **B** With respect to drop copies, firms would like the information in near real time, not daily. Firms would also like more standardization in format and speed and, in some cases, more granularity (i.e., more detailed information by trading account, product, etc.).

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Report on Cyber Security in the Banking Sector

Topic 74

Exam Focus

Cyber attacks against financial institutions are becoming more common, sophisticated, and widespread. This topic describes the key factors contributing to increased cybercrime, the current state and trends in corporate governance of cybersecurity, and the challenges for achieving adequate cybersecurity. For the exam, be able to describe the main factors contributing to an increase in cybercrime against financial institutions. Also, be aware of present trends in cybersecurity corporate governance and cybersecurity challenges that financial institutions face going forward.

Cybercrime Against Financial Institutions

LO 74.1: Describe factors contributing to increased cyber crime against financial institutions.

In 2013, a report was created by the New York State Department of Financial Services regarding cybersecurity. This report was compiled through surveys of 154 financial institutions, including 12 credit unions, 60 community and regional banks, and 82 foreign branches and agencies. The report identifies the following five key reasons for the increase in cybercrime:

- An increase in the occurrence of hostile countries breaking into the computer systems of financial institutions seeking intelligence or intellectual property.
- An increase in the amount of hacktivists (i.e., computer hackers who seek to make political statements with their activities).
- An increase in the amount of criminals (e.g., organized crime) seeking to break into the financial institution systems to steal capital.
- Decreased technology costs have lowered the barriers to entry for cybercrime, which has encouraged criminals to seek out new technological ways to commit cyber fraud.
- An increase in the size of the black market for breached data provides demand to cyber criminals.

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Corporate Governance for Cybersecurity

LO 74.2: Discuss present trends in corporate governance as it relates to cyber security, and explain the implications of these trends.

The high speed of technological change enables the increasing frequency and sophistication of cyber attacks. As computer systems and threats to these systems evolve, corporate governance also needs to evolve. The primary areas of corporate governance with regard to cybersecurity are as follows:

Information technology (IT) system management. Financial institutions typically include a mix of internal and external resources. Very few institutions (less than 12%) rely on completely outsourced IT solutions. Currently, 10% of small institutions and less than 2% of large institutions outsource IT solutions. In the context of this topic, small institutions have assets under $1 billion, medium institutions have assets in the $1 billion to $10 billion range, and large institutions have assets greater than $10 billion.

Information security framework. Most institutions (nearly 90%) have a framework with the following five key pillars:

- A written information security policy.
- Cyber risk management, including key risk identification and trends.
- Employee training and security awareness education.
- Periodic information security audits.
- Incident monitoring and reporting.

Framework robustness positively relates to institutional size with 98% of large institutions and 89% of medium institutions having successfully implemented all pillars. In addition, large institutions often go beyond the five key pillars. For example, 83% of large institutions have a comprehensive communications plan to handle inquiries from customers in the event of a breach, while only 65% of small institutions have a communications plan.

Smaller institutions lagged in the following two areas of the information security framework:

- *Oversight of third-party data service vendors.* Only 62% of small institutions conducted compliance audits on third-party data vendors versus 80% of large and medium institutions.
- *Participation in an information-sharing organization* (i.e., the Financial Services Information Sharing and Analysis Center or FS-ISAC). Only 25% of small institutions are members versus over 60% of large institutions. While limited budgets may contribute to a lack of small institution participation, they could reap benefits from an FS-ISAC at a low cost. Benefits would include:
  - Timely notification and information specifically designed to protect critical systems. The U.S. Department of Homeland Security and the Department of Treasury trust the FS-ISAC to circulate critical information during a crisis.
  - Anonymous information sharing across the financial services industry to exchange information on physical threats, cyber threats, vulnerabilities, incidents, and protective measures.

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Security technology. Security technology varies widely. Institutions commonly utilize data loss prevention (DLP) tools (78% of large institutions, 65% of medium institutions, and 57% of small institutions). Figure 1 details the usage of security technology.

Figure 1: Security Technology Types Utilized by Institutional Size

	Total	*Large Institutions*	*Medium Institutions*	*Small Institutions*
Unauthorized device discovery	57%			
Smartcard or one-time password tokens		93%	76%	52%
Public key infrastructure systems		63%	35%	16%
Biometric tools		33%	27%	13%
Mobile device policies and procedures	Most			
Cloud computing policies and procedures	< 27%*			

** Another 22% expect to introduce cloud computing in the next three years.*

Penetration testing. Ninety-one percent of small institutions and 100% of both large and medium institutions conduct penetration tests (i.e., tests used to identify vulnerabilities) of their computer system, network, and/or applications. Nearly 80% of institutions surveyed conduct annual tests, 9% conduct quarterly tests, and 4% conduct monthly tests.

Budget and costs. These costs are mostly housed within the IT or operations budget. Of the participating institutions, 77% have increased their information security budget in the last three years and another 18% were flat. In addition, 79% of institutions expect further increases over the next three years (90% of large institutions compared to 79% of medium institutions and 84% of small institutions). The primary three drivers cited for higher spending were (1) compliance and regulation, (2) institutional continuity and disaster recovery, and (3) reputational risk.

Corporate governance. Corporate governance around cybersecurity tends to be highly IT centered. Departmental participation in organizations' cybersecurity structure is shown in Figure 2.

Figure 2: Participation in Cybersecurity Efforts

IT Department	92%
Compliance Officer	73%
Risk Management	64%
Chief Executive Officer	61%
Chief Information Officer	60%
Business Operations	57%
General Counsel	29%
Public Information/Communications	25%
Corporate Insurance	22%

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The inclusion of underutilized divisions can only strengthen governance and ensure a complete approach to cyber risk management. For example, general counsel should provide advice with regard to potential liabilities arising from a cyber event, and corporate insurance should review coverage and the extent to which liability coverage for directors and officers is adequate.

About 64% of participants have a dedicated information security executive. Results varied by institutional size with 80% of large institutions having a dedicated executive compared to 54% for small institutions. The reporting line of communication varies dramatically with 25% of these executives reporting to the board of directors, 33% to the chief executive officer (CEO), and 22% to the chief information officer (CIO).

Frequency of security updates is driven by level with updates to the board less often than senior management. Update frequency is as follows:

- Board of directors: 73% received quarterly or annual updates.
- Chief executive officer: 22% monthly, 24% quarterly, and 30% annually.
- Senior managers: 33% received monthly updates.

Ad hoc information security updates, likely in response to a specific event or imminent risk, were also delivered to board of directors (21%), CEOs (37%) and senior management (34%). A small number never sent updates to the board (< 7%), the CEO (< 4%), or senior management (< 1%), or relied only on ad hoc updates. This represents an area needing improvement. Regular updates should be provided to all management levels, including the board, to ensure the institution's cyber risk is appropriately weighted and managed. It may also enable the IT department to more effectively compete for funding if the board or executive level management is better aware of the institution's cyber risk.

Cyber incidents and breaches. The majority of institutions experienced cyber intrusions or attempted intrusions over the past three years. The incidents of malware and phishing attempts were positively correlated to the size of the institution.

The most common types of wrongful activity were account takeovers (46%), identity theft (18%), telecom network disruption (15%), and breaches of data integrity (9%).

Although institutions reported numerous attempts over the prior year, very few experienced successful breaches resulting in significant losses. Common sources of monetary losses are customer reimbursements (76%), audit and consulting (52%), and deployment of detection software, services, and policies (45%).

Achieving Adequate Cybersecurity

LO 74.3: Assess the greatest challenges financial institutions face in achieving adequate cyber security.

With regard to cybersecurity, the key challenges include increasing threat sophistication, emerging technologies, and a tendency for security budgets to lag new product/commercial investment.

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Future Planning

While the majority of institutions have an information security strategy for the next one to three years, several, particularly smaller institutions, do not. Strategies in place by size are >90% large institutions, 80% medium institutions, and 62% small institutions.

However, only 49% of institutions said their strategies adequately address new/emerging risks, 31% said modification is necessary, and 22% still need to investigate further before they understand their risks.

Most institutions cited external factors as their greatest challenge to building a cybersecurity program. Barriers to ensuring security cited by institutions include:

- Increasing sophistication of threats (71%).
- Emerging technologies (53%).
- Lack of sufficient budget (8%).
- Lack of visibility and organizational influence (6%).

Challenges Going Forward

While institutions have taken strides in recent years to bolster cybersecurity, the speed of technological change and increasingly sophisticated attacks will remain a major threat. Competitive pressures often lead to security lagging behind new product development. Money spent is not the best reflection on program security. Expensive software that is rarely updated or ineffectively deployed makes little contribution. Much more relevant is the institution's ability to identify the chief cyber risks and create an appropriate program. There is no one-size-fits-all solution.

It is increasingly critical that financial institutions take advantage of information sharing and analysis resources. The New York Department of Financial Services has recommended that all New York-charted depository institutions become members of FS-ISAC. Institutions seem increasingly willing to share information, especially with regard to specific threats and solutions.

Financial institutions rely substantially on the processes and controls instituted by third parties. However, these institutions must conduct appropriate due diligence and regular monitoring of these providers to reduce the risk associated with outsourcing.

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Key Concepts

LO 74.1

The key factors that have led to increased cybercrime include:

- Unfriendly countries.
- Increasing number of hacktivists.
- Cyber criminals.
- Lower barriers to entry for cybercrime due to decreased technology costs.
- Expanding black market for breached data.

LO 74.2

Cybersecurity trends include:

- IT system management. Most institutions use both internal and external IT resources.
- Information security framework. Most institutions (nearly 90%) reported an information security framework that includes the following key pillars: (1) written information security policy, (2) security awareness education and employee training, (3) risk management, including key risk identification and trends, (4) information security audits, and (5) incident monitoring and reporting. Larger institutions are likely to have more extensive framework features. Smaller institutions lagged in oversight of third-party data service vendors and membership in FS-ISAC.
- Security technologies. These vary widely and are generally deployed by institutions of all sizes.
- Penetration testing. The majority of institutions surveyed conducted annual penetration testing to identify system vulnerabilities.
- Budget and costs. Seventy-seven percent of participating institutions have increased the size of their information security in the last three years and another 18% were flat.
- Corporate governance. This tends to be highly IT centered. Lagging areas of participation include public information/communications, general counsel, and corporate insurance. Senior managers are updated monthly at 33% of institutions, CEOs are updated monthly at 22% of institutions, and board level updates were at least annual or quarterly at 73% of institutions. Ad hoc information security updates, likely in response to a specific incident or risk, were also delivered to board of directors (21%), CEOs (37%), and senior management (34%).
- Cyber incidents and breaches. Most institutions experienced intrusions or attempted intrusions over the past three years with higher frequency at larger institutions.

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LO 74.3

The key cybersecurity challenges include increasing threat sophistication, emerging technologies, and tendency for security budgets to lag new product/commercial investment.

Most institutions cite external factors as their greatest challenge to building an adequate cybersecurity program. Barriers to ensuring security most cited by institutions include:

- Increasing sophistication of threats (71%).
- Emerging technologies (53%).

Competitive pressures often lead to security lagging behind new product development. It is increasingly critical that financial institutions take advantage of information sharing and analysis resources. Financial institutions rely in large part on the processes and controls put in place by third parties and should conduct appropriate due diligence and monitoring.

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Concept Checkers

1. Which of the following statements is not one of the five key reasons behind the recent increase in cybercrime?
   A. Unfriendly nations breach systems to seek intelligence or intellectual property.
   B. Increased prevalence of hacktivists.
   C. Increasing technology costs mean criminals can pursue cyber fraud, which results in decreased event frequency but higher event costs.
   D. Criminals, such as organized crime groups and cyber gangs, breach systems for monetary gain.

2. Which of the following lists of key pillars should be included in an information security framework?
   I. Written information security policy, risk elimination, and security awareness education and employee training.
   II. Information security audits, counterattacks, and incident monitoring reporting.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

3. Which of the following statements are benefits to a smaller institution participating in the Financial Services Information Sharing and Analysis Center?
   I. Timely notification and information specifically designed to protect critical systems.
   II. Anonymous information-sharing capability with entire financial services industry.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4. Which of the following statements is not true with respect to financial institution budgeting and cost trends for IT cybersecurity?
   A. Most institutions have increased their information security budget the past three years, and most expect to increase it further.
   B. Compliance and regulation is a primary driver of increased spending in the near future.
   C. Given that most major challenges are being met, information security spending budgets should decline during the next three years.
   D. Business continuity and disaster recovery is a primary driver of increased spending in the near future.

5. Which of the following actions is not a key cybersecurity challenge going forward?
   A. Increasing threat sophistication.
   B. Emerging technologies.
   C. Tendency for security budgets to lag new product/commercial investment.
   D. The need to increase the adoption of penetration testing by medium institutions.

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Concept Checker Answers

1. **C** Decreasing technology costs lower barriers to entry for cybercrime, making it easier and cheaper for criminals to seek out new ways to commit cyber fraud. The other choices are valid reasons for the increase in cybercrime.

2. **D** The information security framework should include the following key pillars: (1) written information security policy, (2) security awareness education and employee training, (3) risk management, including key risk identification and trends, (4) information security audits, and (5) incident monitoring and reporting. Risk elimination and counterattacks are not key pillars so, therefore, neither list is accurate.

3. **C** Both statements are accurate. Benefits to smaller institutions include timely notification and information specifically designed to protect critical systems, along with anonymous information-sharing capability with entire financial services industry.

4. **C** Cyber attacks continue to worsen and are constantly evolving. The other statements are accurate.

5. **D** Key cybersecurity challenges include increasing threat sophistication, emerging technologies, reliance on third-party service providers, and tendency for security budgets to lag new product/commercial investment. One hundred percent of large and medium institutions already utilize penetration testing, so an increase is not necessary.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:"

Framework for Improving Critical Infrastructure Cybersecurity

Topic 75

Exam Focus

The security of the United States is contingent on critical infrastructure systems functioning properly. This topic presents methods available to public, private, and non-U.S. organizations for improving the cybersecurity of critical infrastructure. For the exam, understand how an organization can benefit from using a voluntary, risk-based framework. Also, be able to explain how to address privacy and civil liberties concerns associated with cybersecurity operations.

In 2013, President Obama issued *Executive Order 13636: Improving Critical Infrastructure Security*. This order laid out policies for improving the security of critical infrastructure both in the United States and globally. The order mentioned a need to create a voluntary **Cybersecurity Framework** (i.e., the Framework). The Framework would contain best practices and industry-wide standards and would be used to address and reduce the risks associated with cybercrime. Benefits of the Framework to companies include an efficient way to reduce cybersecurity risk while avoiding the burden of government regulations and infringing on individuals' rights. A key point is that the Framework exists to support the organization's decision making, activities, and risk management needs. The Framework is divided into the following three sections:

1. The Framework Core.
2. The Framework Implementation Tiers.
3. The Framework Profile.

The Framework Core

LO 75.1: Explain the five core functions in the framework that an organization can use to mitigate cyber security risk, and provide examples of activities associated with each function.

The **Framework Core** provides an outline of activities that enable an organization to achieve improved cybersecurity outcomes. Each function within the Framework can be subdivided into categories of outcomes, and each category can be further broken down into subcategories that detail specific support activities. In addition, each subcategory should be complemented with informative references that illustrate how outcomes should be achieved. The Framework starts with, and is rooted in, the following five core functions: (1) identify, (2) protect, (3) detect, (4) respond, and (5) recover.

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The core functions form an operational framework and are intended to be performed concurrently and continuously. They are not a checklist nor is there a static end because the threat environment is constantly evolving. In the following section, the five functions are explained in more detail.

Identify: Every organization should develop its own understanding of the threat environment to protect its systems, assets, data, and capabilities. Understanding the business context, resources that back critical functions, and related risks enable the organization to prioritize its efforts and develop a risk management strategy suitable to its business needs. Example categories include:

- Asset management.
- Business environment.
- Governance.
- Risk assessment.
- Risk management.

Protect: After key priorities are identified, the organization can develop and implement specific protections to improve the reliability of critical infrastructure services. Example categories include:

- Access control.
- Awareness and training.
- Data security.
- Information protection processes and procedures.
- Maintenance.
- Protective technology.

Detect: Develop and implement appropriate activities to identify the timely occurrence of a cybersecurity event. Example categories include:

- Anomalies and events.
- Detection processes.
- Security continuous monitoring.

Respond: Develop and implement action plans for detecting cybersecurity events. Example categories include:

- Analysis.
- Communications.
- Improvements.
- Mitigation.
- Response planning.

Recover: Develop and implement resilience plans to restore capabilities and services impaired due to a cybersecurity event. Example categories include:

- Communications.
- Improvements.
- Recovery planning.

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The Framework Implementation Tiers

LO 75.2: Explain how an organization can implement and communicate a process to manage cyber security risk.

The **Framework Implementation Tiers** enable an organization to understand current cybersecurity risks and how to manage and mitigate those risks. The definitions of each tier and the components to each tier (risk management process, integrated risk management program, and external participation) are shown in Figure 1. An organization will select the tier that meets its organizational and cybersecurity goals. Note that any moves to higher tiers should only be considered if the benefits outweigh the costs.

Figure 1: Framework Implementation Tiers

Tiers	*Risk Management Process*	*Integrated Risk Management Program*	*External Participation*
Tier 1: Partial	Practices for risk management not formalized; managed reactively.	None	No process in place to coordinate or collaborate with other entities.
Tier 2: Risk Informed	Practices for risk management approved but not established.	Awareness of risks; informal information sharing within organization.	Knows role in larger ecosystem but no formal information sharing process.
Tier 3: Repeatable	Practices for risk management formally approved; part of organizational policy.	Organization-wide approach is in place.	Understands dependencies and receives information from partners.
Tier 4: Adaptive	Lessons learned and predictive indicators used to adapt cybersecurity practices.	Management approaches in place and part of organizational culture.	Actively shares information with partners.

The Framework Profile

The **Framework Profile** aligns the organization's business requirements, risk tolerance, and available resources with the core functions, categories, and subcategories. A profile enables the organization to establish a plan for reducing risk that is aligned with company and sector goals, considering legal/regulatory requirements, best practices, and risk management priorities.

Profiles can describe either the current state (i.e., **current profile**) or the desired target state (i.e., **target profile**) of activities and outcomes to meet cybersecurity risk management goals. Profiles also support business/mission requirements and facilitate communication of risk both within and between organizations. The Framework does not issue a template for profiles, which allows for implementation flexibility.

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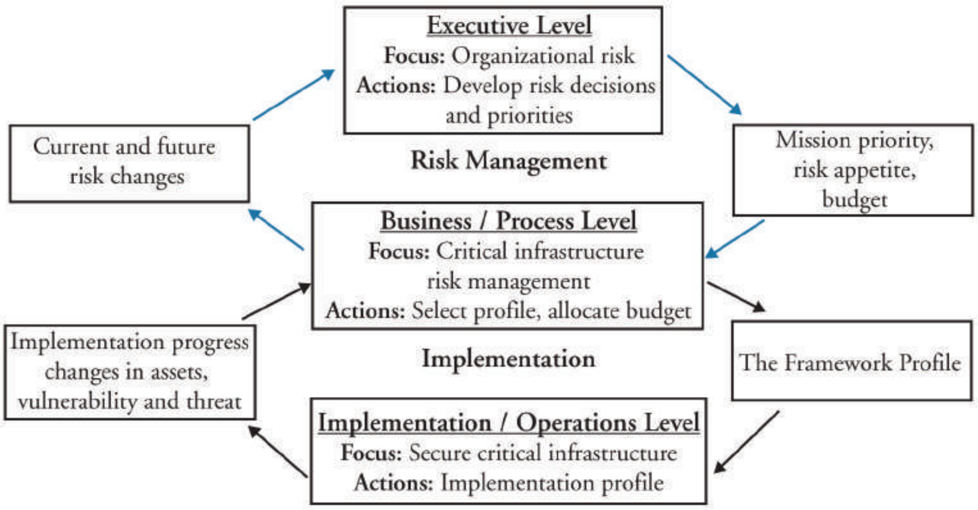
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Organizations should compare current profiles to target profiles to identify any gaps in cybersecurity goals. After gaps are identified, an organization should develop an action plan to close those gaps. Prioritizing which gaps to close first should be driven by business needs and risk management practices. This risk-based approach allows determination of required resources (e.g., human and monetary) to accomplish cybersecurity goals in a cost-effective and prioritized fashion.

Coordinating Framework Implementation

Coordinating Framework implementation begins with the executive level management team transmitting priorities, available resources, and risk tolerance to the business/process level. The business/process level inputs this data into the risk management process, collaborating in turn with the implementation/operations level to transmit business needs and create a Framework Profile. The implementation/operations level then transmits implementation progress back to the business/process level, which performs impact assessment and reports back to the executive level. Figure 2 illustrates the processes and feedback loops.

Figure 2: Organizational Information Flow



Applying the Framework

Any organization can use the Framework to identify, assess, and manage cybersecurity risk. Rather than replace existing processes, an organization should overlay the Framework onto the existing process to determine gaps and develop an improvement roadmap.

Review of Cybersecurity Practices

The Framework allows for the comparison of an organization's cybersecurity activities with those detailed in the Framework Core. Creating and comparing current and desired target profiles enables an organization to identify gaps between current and desired outcomes in categories that are aligned with the five high-level core functions (i.e., identify, protect, detect, respond, and recover). While this process is not a substitute for a comprehensive

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risk management process, the core functions allow executives and other employees to refine fundamental concepts, assess how risk is managed, and compare the organization's cybersecurity practices to industry standards.

Creating or Optimizing a Cybersecurity Program

The following steps demonstrate how an organization can use the Framework to create an effective **cybersecurity program** or improve an existing one. These steps will need to be repeated as new threats emerge.

Step 1: **Prioritize and Scope.** An organization identifies its business objectives along with high-level priorities. Strategic decisions are made regarding implementation and scope of supporting systems and assets. The Framework can be tailored to various business lines and processes according to need and risk tolerance.

Step 2: **Orient.** After the scope of the program is determined, the organization identifies related systems and assets, regulatory requirements, and an overall risk approach. Next, threats to and vulnerabilities of those systems and assets are identified and documented.

Step 3: **Current Profile Creation.** This is developed by indicating which category and subcategory outcomes from the Framework core are presently being achieved.

Step 4: **Risk Assessment.** Starting with the current risk management process and/or previous risk assessment, the organization analyzes the operational environment to forecast the probability of a cybersecurity event and its impact on the organization. Emerging risks and vulnerability data should be included in the risk assessment to facilitate robust understanding of likelihood and impact.

Step 5: **Target Profile Creation.** The organization focuses on creating a target profile, which allows it to evaluate Framework categories and subcategories. The organization may develop its own additional categories/subcategories to address unique organizational risks. The requirements of external stakeholders (e.g., customers, sector entities, and partners) should also be considered.

Step 6: **Identify, Analyze, and Prioritize Gaps.** The organization compares current and target profiles to determine gaps and then creates a prioritized action plan to eliminate those gaps. It should utilize mission drivers, a cost/benefit analysis, and its understanding of risks to achieve the desired target profile outcomes. It should also determine the required resources that will be used to deal with the gaps. Using profiles in this manner enables informed decisions, supports risk management, and promotes cost-effective, targeted enhancements.

Step 7: **Implement Action Plan.** The organization decides which actions to take (from Step 6), if any, to close gaps, then monitors current practices against the target. The Framework also identifies sample informative references, but companies should determine which standards and practices are best suited for their unique situation.

Addressing Privacy and Civil Liberties Concerns

LO 75.3: Describe methodologies an organization can use to address privacy and civil liberties concerns associated with cyber security operations.

Privacy and civil liberties implications must be considered when personal information is used, collected, processed, maintained, or disclosed within an organization's cybersecurity

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activities. This approach is intended to be a general list of considerations and processes because privacy and civil liberties implications differ by sector, and organizations may address these implications with a range of implementations.

Organizations should consider how to incorporate the following principles of privacy and civil liberties:

1. Minimize data used in the collection, disclosure, and retention of personal information.

2. Ensure that usage limitations, outside of cybersecurity activities, for collected information exist and are enforced.

3. Be transparent, when appropriate, regarding cybersecurity activities.

4. Require individual consent and compensate individuals for any damages in the event of a breach.

5. Ensure the quality, integrity, and security of data.

6. Be accountable and conduct regular audits.

Figure 3 outlines activities and processes that should be considered when addressing these principles.

Figure 3: Cybersecurity Activities and Processes

Activity	*Process*
Governance of cybersecurity risk	• Organizational assessment of cybersecurity risk and response considers privacy implications. • Individuals with cyber-related privacy responsibility are trained and report to appropriate management. • Process to comply with regulations, privacy laws, and constitutional requirements. • Process to assess implementation of organizational measures and controls.
Selecting and authorizing individuals to access organization's assets and systems	• Steps are taken to enhance access control measures involving personal information, if necessary.
Awareness and training measures	• Cybersecurity training incorporates applicable information on organizational privacy policy. • Service providers of cyber-related services to the organization are also informed.
Abnormal activity detection and system and assets monitoring	• Process to conduct privacy review of anomalous activity detection and cybersecurity monitoring.
Response activities, including information sharing or other mitigation efforts	• Process to assess personal information sharing outside the organization as part of cybersecurity information-sharing activities. • Process to conduct a privacy review of cybersecurity mitigation efforts.

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Key Concepts

LO 75.1

The Framework Core provides an outline of activities, along with examples that enable an organization to achieve improved outcomes. The five core functions form an operational framework and are intended to be performed concurrently and continuously. They are not a checklist nor is there a static end because the threat environment is constantly evolving. The core functions are as follows:

- Identify. Every organization should develop its own understanding of the threat environment to protect its systems, assets, data, and capabilities.
- Protect. Once key priorities are identified, the organization can create specific safeguards to ensure delivery of critical infrastructure services.
- Detect. Develop and implement appropriate activities to identify the timely occurrence of a cybersecurity event.
- Respond. Develop and implement action plans for detected cybersecurity events.
- Recover. Develop and implement resilience plans to restore capabilities and services impaired due to a cybersecurity event.

LO 75.2

Framework implementation tiers are established to provide measurement for how an organization views its cybersecurity risk and the current risk management processes. The four tiers range from Tier 1 (Partial) to Tier 4 (Adaptive).

The Framework Profile aligns functions, categories, and subcategories with the organization's business requirements, risk tolerance, and available resources.

An organization can use the Framework to create a new cybersecurity program or improve an existing one by utilizing the following steps:

Step 1: Prioritize and Scope.
Step 2: Orient.
Step 3: Current Profile Creation.
Step 4: Risk Assessment.
Step 5: Target Profile Creation.
Step 6: Identify, Analyze, and Prioritize Gaps.
Step 7: Implement Action Plan.

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LO 75.3

Privacy and civil liberties should be considered when personal information is used, collected, processed, maintained, or disclosed within an organization's cybersecurity activities.

Organizations should consider how to incorporate the following principles of privacy and civil liberties:

1. Data minimization in the collection, disclosure, and retention of personal information.
2. Usage limitations outside of cybersecurity activities with collected information.
3. Transparency for certain cybersecurity activities.
4. Individual consent and compensation for adverse effects.
5. Data quality, integrity, and security.
6. Accountability and auditing.

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Concept Checkers

1. The five core functions of the Cybersecurity Framework should be executed in what order and how often?
   A. Sequentially and at least once per year.
   B. Sequentially and on a continuous basis.
   C. Concurrently and at least once per year.
   D. Concurrently and on a continuous basis.

2. Which of the following statements is true with respect to the five core functions within the Framework?
   A. The core functions include identify, detect, and recover.
   B. The core functions include prevent, respond, and monitor.
   C. It is important that organizations check off every component of the Framework Core in order.
   D. The Framework is a simple checklist, and each organization, using all five core functions, should utilize the Framework according to its needs.

3. Which of the following components is not part of each Framework Implementation Tier?
   A. Risk management process.
   B. Integrated risk management program.
   C. Estimated completion time.
   D. External participation.

4. Which of the following statements is least likely an advantage of using current and target profiles?
   A. Creating a current profile enables an organization to determine which outcomes are currently being achieved.
   B. Creating a desired target profile allows an organization to compare current and target outcomes and identify cybersecurity gaps.
   C. Action plans can be developed to address any cybersecurity gaps.
   D. Implementation of action plans to address all cybersecurity gaps must occur immediately.

5. Which of the following statements is true regarding the incorporation of privacy and civil liberties concerns into cybersecurity activities?
   I. Organizational members have no rights with respect to privacy; the priority is cybersecurity.
   II. Cybersecurity personnel engaged in activities where privacy and civil liberties concerns are relevant must be trained and report to appropriate management.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

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Concept Checker Answers

1. **D** The core functions of the Framework should be executed concurrently and on a continuous basis.

2. **A** The five core functions are identify, protect, detect, respond, and recover. The Framework should not be used as a checklist. Each organization, using all five functions, should utilize the Framework according to its needs.

3. **C** The threat environment is constantly evolving, so there is no estimated completion time. The three components of the Framework Implementation Tiers are risk management, integrated risk management program, and external participation.

4. **D** Though action plans are developed to address all gaps, the organization should actually prioritize gaps based on business/mission requirements, cost/benefit analysis, and available resources.

5. **B** Cybersecurity personnel engaged in activities where privacy and civil liberties concerns are relevant must be trained and report to appropriate management. Organizations must carefully consider the civil liberties and privacy of individuals (both internal and external) when creating and utilizing a cybersecurity plan.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

The Changing Landscape for Derivatives

Topic 76

Exam Focus

This topic examines the world of over-the-counter (OTC) derivatives trading, comparing the trading environment prior to the credit crisis of 2007–2009 to the new environment in the post-crisis world. For the exam, the focus should be on the post-crisis world; specifically where trades should take place, how they should clear, margin requirements, reporting requirements, and the posting of collateral. As it relates to clearing, the role of the central counterparty (CCP) is critical; be sure to understand how a CCP functions and the risks that are involved from the perspective of both market participants and the CCP itself.

Over-the-Counter Trading

LO 76.1: Discuss the background and current status of OTC trading.

The **over-the-counter (OTC) derivatives market** can be analyzed in two periods: pre-credit crisis (i.e., before 2007–2009) and post-credit crisis. In the pre-crisis world, there was limited regulation. Transactions (including clearing methods and collateral posting) were simply agreed upon by market participants who often arranged these transactions either over the phone or through an interdealer broker.

In the post-credit crisis world, the goal is that all "standardized" OTC derivatives will be traded on exchanges or electronic platforms. Leading this effort is the United States, which through the **Dodd-Frank Act** of 2010, requires the use of **swap execution facilities** (SEFs) for the trading of standardized derivatives contracts. SEFs serve as electronic platforms where any market participant can post and accept a bid or offer from another market participant. A similar platform for the European Union is the **Organized Trading Facilities** (OTFs), although they are not as established as SEFs.

In the pre-crisis era, large banks would dominate the market and earn significant spreads by serving as market makers for OTC derivatives transactions. Increases in the number of market makers and market participants taking opposite sides of transactions in the post-crisis world will likely erode the advantage of these large banks and take away much of their spread income.

The distinction between the OTC and exchange-traded markets is becoming somewhat gray, as OTC markets are being forced to act like exchange-traded markets through post-crisis regulations. Exchange-traded markets try to develop nonstandard products in order to compete with OTC markets.

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Central Counterparties

LO 76.2: Discuss how a central counterparty (CCP) can operate as an OTC derivative trading venue with respect to clearing and reporting.

Clearing an OTC derivatives transaction can occur bilaterally or centrally. If **bilateral clearing** is used, both sides of the transaction use an agreement (often an **ISDA Master Agreement**) to establish clearing terms. If one party fails to post collateral [terms of which are usually established in a **credit support annex** (CSA)], doesn't make payments, or declares bankruptcy, the ISDA Master Agreement will establish how to handle these events.

If central clearing is used, the clearing is managed by a **central counterparty** (CCP) whose members are the market participants engaging in the OTC derivatives transactions. CCPs act much like a futures clearinghouse in that they represent the intermediary between two parties to a transaction. In order to protect itself from member defaults and unfavorable market movements, the CCP requires that members post initial and variation margin as well as contribute to a default fund. Any member that does not post variation margin is in default and will see its positions closed out, with the likely loss covered by the member's initial margin and default fund contribution followed by other member default contributions and the CCP's equity if needed.

Regulations require that CCPs must be used in the post-crisis world for all standardized interdealer trades, with bilateral clearing still used for nonstandard, foreign exchange and nonfinancial end user transactions. Even for bilateral clearing, new regulations will pose margin and collateral requirements that frequently did not exist in the past.

Central clearing through a CCP may provide more flexibility than bilateral clearing from a netting perspective, but the benefits may only be realized when a party's transactions are all with other members of the same CCP. In addition, it is very likely that because many transactions still clear bilaterally, a market participant may have some of its transactions clearing bilaterally while others clear centrally.

From a reporting perspective, OTC derivatives transactions are much more transparent now than they were in the pre-crisis world. Regulations now require the reporting of all transactions to a **central trade repository**. The repository in the United States is the **Commodity Futures Trading Commission** (CFTC), while the repository in Europe is the **European Securities and Markets Authority** (ESMA).

Too-Big-To-Fail CCPs

LO 76.3: Explain the concept of too-big-to-fail CCPs, and discuss some points of weakness in this concept.

The credit crisis ultimately resulted in the bailout (by governments) of banks that were deemed "**too big to fail**." In other words, the failure of one of these banks could have such a negative effect on the economy overall that government intervention becomes the only way to avoid it. The concern with the new derivatives regulations in the post-crisis world is that taking the place of these banks are now CCPs that are "too-big-to-fail."

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The main purpose of a CCP is to serve as an intermediary for derivatives transactions. As such, it is a less complex structure than a bank. In addition, a CCP can limit its default risk by following good practices in valuing transactions, calculating default fund and initial margin contributions, and choosing its members.

A CCP must be able to properly value a transaction and unwind a position if one side defaults. In the event a CCP lacks the experience to value a specific transaction, it could always utilize a third-party dealer to assign a value. The bigger concern is unwinding a position, but one option is for a CCP to require that its members with opposite transactions (to the defaulting member's side) unwind a portion (or all) of their positions in order to execute the unwind. These members must ultimately be compensated (through a combination of margin and default funds) for any losses due to unfavorable market movements. As a result of this option, a CCP will not only be able to clear more transactions, but it will also have a lower risk of failure due to its members taking on the responsibility of unwinding defaulted positions.

From a collateral perspective, additional requirements will result in an increase in the amount of liquid assets (such as cash and government securities) that market participants must have on hand in order to meet margin requirements. Also, limitations on **rehypothecation** (i.e., using the same collateral posted by one counterparty to meet collateral requirements by another counterparty) will result in additional liquidity pressures that did not exist in the pre-crisis world.

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Key Concepts

LO 76.1

In the years after the credit crisis of 2007–2009, there have been significant increases in regulations and requirements for individuals and entities engaged in OTC derivatives transactions. Exchanges or electronic platforms are now required in the United States (and soon in Europe) for standardized OTC derivatives transactions.

LO 76.2

For derivatives transactions that do not clear bilaterally, a central counterparty (CCP) serves as an intermediary between market participants. A CCP takes the opposite side of each transaction and, therefore, requires contributions for both margin and default funds in order to protect itself from default risk.

LO 76.3

The concern that a CCP may be "too big to fail" can be mitigated by following good practices in valuing transactions, calculating default fund and initial margin contributions, and choosing its members. Risk is lowered as long as a CCP can properly value transactions (and utilize third-party valuations, if needed) and assign the burden of unwinding defaulted positions to its members.

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Concept Checkers

1. A U.S. over-the-counter (OTC) derivatives investor in the post-credit crisis world will most likely find that:
   A. large banks will continue to dominate the OTC derivatives market.
   B. collateral requirements will be defined after the transaction is settled.
   C. standardized contracts will still have flexibility as to how they are traded.
   D. OTC markets are behaving more like traditional exchange-traded markets.

2. All of the following are required to be posted by members of a central counterparty (CCP) except for:
   A. initial margin.
   B. variation margin.
   C. default fund contributions.
   D. CCP reserve fund contributions.

3. Which of the following statements is an advantage to utilizing central clearing rather than bilateral clearing for an OTC derivatives contract?
   A. Clearing terms are established through an ISDA Master Agreement.
   B. Collateral requirements are clearly identified in a credit support annex.
   C. The CCP absorbs the credit risk from the traders on each side of the trade.
   D. More (rather than less) flexibility in terms of collateral and clearing requirements.

4. From the perspective of a CCP, default risk can be mitigated through all of the following options except:
   A. using a third party to value complicated and unfamiliar transactions.
   B. evaluating the creditworthiness of its current and potential members.
   C. lowering initial margin requirements in order to increase trading volume.
   D. accurately assessing margin and default fund contributions required from its members.

5. A member of a CCP defaults on an OTC derivatives contract due to unfavorable market conditions. In order to fund the default, the CCP will likely go to which of the following sources first?
   A. The CCP's own equity reserve.
   B. The defaulting member's initial margin.
   C. Other members' contribution to the default fund.
   D. The defaulting member's default fund contributions.

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Concept Checker Answers

1. **D** As a result of increased regulations in the post-credit crisis world, the United States has required the use of swap execution facilities (SEFs) for standardized derivatives contracts. This requirement makes transactions much more like regular exchange-traded transactions than traditional OTC transactions (which tend to be more like nonformal agreements between two parties).

2. **D** There is no such thing as a defined "CCP reserve fund contribution." Initial margin, variation margin, and default fund contributions are all requirements of CCP members in order to protect the CCP from unfavorable market movements and/or member defaults.

3. **C** A significant advantage of central clearing (through a CCP) is that the CCP acts as an intermediary between both sides of a trade. This allows each side to enter into a transaction without worrying significantly about whether the other side will default. There is still a potential impact to the CCP and its members when default occurs, but it is not nearly as significant as it would be in a bilateral clearing situation.

4. **C** Lowering initial margin requirements will have the effect of potentially increasing the amount of variation margin needed when the market moves against a position. A higher amount of variation margin makes it more likely that it will not be met, leading to a higher risk of default.

5. **B** When a specific member defaults, the CCP will first look to fund the default with the initial margin contributions of the member. Since members should all have contributed to the default fund of the CCP, the individual defaulting member's contribution to this fund will be accessed if the initial margin amount is insufficient to fund the shortfall. Other members' default fund contributions are next, and finally, if there is still a shortfall, the CCP's equity may be accessed.

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The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Valuing Derivatives: Funding Value Adjustments and Fair Value

Topic 77

Exam Focus

This topic examines funding value adjustments potentially made by a derivatives dealer in transaction and portfolio valuation. For the exam, understand how these adjustments are applied, as well as their "value" from different financial and theoretical perspectives and the implications of including them in valuation. Also, a dealer may incorporate several other adjustments in addition to (or in place of) a funding value adjustment; be familiar with these other adjustments and when they should or should not be included in valuations.

Funding Value Adjustments

LO 77.1: Understand the use and purpose of funding value adjustments (FVA).

In order to theoretically recover the average funding cost assessed to a derivatives trade or to a derivatives portfolio, a dealer will make a **funding value adjustment** (FVA). The FVA is a mathematical adjustment made by the dealer, which allows for the recovery of average funding costs for any transactions that are uncollateralized.

The return on capital measure, often used to assess financial performance on derivatives activities, includes funding costs, which for derivatives trades may be calculated by applying the average funding rate to the average funding used. The goal for the dealer is to use the FVA (if needed) to recover these funding costs.

LO 77.2: Compare and contrast the view on funding FVA from the perspectives of trading, accounting and financial theory.

From the perspective of the *trader*, the bank is going to charge its derivatives desk the average funding cost (associated with the bank). For any trades that are uncollateralized, the derivatives desk has to make an FVA in order to not show a loss for trades requiring funding. The trades that actually generate funding result in a beneficial FVA because external funding requirements for the bank are reduced. The price from the trader's perspective may be very different than the appropriate price from the perspective of the accountant and theoretician.

From the perspective of the *accountant*, funding costs are irrelevant. The prices at which derivatives are valued should be based on fair value exit prices (which are market based rather than entity specific). Since only one price should exist that clears the market,

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accountants argue that FVAs result in pricing the same transaction differently by different banks.

From the perspective of the *theoretician*, funding costs are irrelevant. The riskiness of a project should ultimately determine the discount rate used to value a project's cash flows. Derivatives, in fact, should be valued using a risk-free discount rate [either LIBOR or the overnight indexed swap (OIS) rate]. OIS rates are typically used by dealers for collateralized transactions. For uncollateralized transactions, it is more likely that an FVA will be used.

Use of the FVA implies that products should be valued (at least in part) at cost, which goes against financial theory that the risk of a project should ultimately determine the discount rate and its market value. The weighted average cost of capital is a single rate that is often used for project valuation. The effect of using only one rate (irrespective of funding) is that risky projects are more likely to be undertaken, which represents a significant argument against using only one rate.

Comparing FVA, DVA, and CVA

LO 77.3: Distinguish between FVA and debit (or debt) value adjustment (DVA) and credit value adjustment (CVA).

The **no-default value** (NDV) for a derivatives transaction assumes that both sides of the transaction will meet their obligation. Financial theory states that derivatives should be valued using a risk-free rate which, therefore, produces a no-default value. Also, prices in the interdealer market should (in theory) reflect an NDV because trades must be fully collateralized.

For bilaterally cleared transactions, collateral may not be sufficient to avoid a default, and credit risk can be significant. As such, a dealer will make an adjustment called a **credit value adjustment** (CVA) to account for the potential of counterparty default and a **debit (or debt) value adjustment** (DVA) to account for the possibility that the dealer will default.

As discussed earlier, the FVA is used to adjust for the dealer's average funding cost for uncollateralized transactions. Mathematically, it represents the difference between NDV using a risk-free discount rate versus NDV using the dealer's cost of funds as the discount rate.

The following equation reflects these adjustments to NDV for a portfolio of transactions that a dealer may have with a single counterparty:

portfolio value = NDV – CVA + DVA – FVA

In terms of the DVA, a further differentiation is required to separate the derivatives obligations from the funding required for those obligations. **DVA1** represents the value to a bank from the possibility that it might default on the derivatives obligations in its portfolio. **DVA2** represents the value to a bank from the possibility that it might default on the funding required for its derivatives portfolio.

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For derivatives transactions that require funding, FVA represents a cost and DVA2 represents a benefit; the opposite is true when transactions provide funding. These two adjustments will cancel each other out in situations where the entire credit spread serves as compensation for default risk, and as such, the previous equation may be restated as follows:

portfolio value = NDV – CVA + DVA1 + DVA2 – FVA

or

portfolio value = NDV – CVA + DVA1

From the perspective of a dealer who purchases an option, the option represents an asset and DVA1 is, therefore, equal to zero. If an option is sold, DVA1 is equal to negative FVA (since FVA is a benefit). DVA1 will add value to the dealer's position because a potential dealer default represents a benefit. Since both FVA and DVA1 provide a benefit to the dealer for sold options, including both in valuations is, in essence, double counting. If DVA2 and FVA are offsets to one another, the inclusion of only DVA1 is more appropriate for derivatives valuation.

FVA Implications

LO 77.4: Evaluate the implications of using FVA, including the potential for arbitrage.

As shown in the previous equations, FVA is a subtraction from portfolio value. If FVA is accounted for in the pricing calculations, the higher the funding costs from the dealer perspective, the lower the value. If funding costs are high, dealers are more likely to sell (rather than buy) options; this leads to a potentially "unbalanced" book from a long/short perspective.

Derivatives are easily traded. Arbitrage opportunities exist whenever the same product or transaction is valued at different prices in different markets. If the price is different across markets, the derivatives trader will buy in the lower-priced market and sell in the higher-priced market. Arbitrage may exist if both FVAs and DVA1s are incorporated into valuations, as well as in situations where incremental DVA1 is less than incremental FVA. In situations where dealers make FVAs but not DVA1s, arbitrage (though more difficult to execute) is still possible.

The risk of arbitrage is one of the arguments for valuing derivatives at market values rather than at cost. Unique costs, whether they represent things like funding, capital constraints, liquidity constraints, and so forth, impact valuation. These costs are irrespective of the true market price (i.e., fair value), and this is an important distinction. While borrowing (and other) costs will realistically influence whether a purchase or sale is made at a given price, the fair value price is set outside of those funding parameters.

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An FVA is an entity-specific adjustment that results in different valuation estimates for different dealers; this inherently makes it impossible to be consistent with fair value (market) prices. A bank could incorporate FVA into valuations for evaluating the performance of its derivatives desk, but this would potentially be inconsistent with its external financial reporting.

Given the concerns with FVA, the most appropriate adjustments to derivatives portfolios seem to be CVA and DVA1 (without adjusting for DVA2 and FVA).

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Key Concepts

LO 77.1

In theory, a funding value adjustment (FVA) is incorporated by a dealer into its derivatives valuations in order to account for the funding costs assigned to the derivatives desk for uncollateralized transactions. FVA represents a cost for transactions that require funding.

LO 77.2

Traders want to incorporate FVA in their valuations in order to recoup the average funding cost charged to them. Accountants and financial theoreticians feel that derivatives valuations should be based on market prices at fair value (using a risk-free discount rate) rather than having a "cost" basis that incorporates entity specific funding costs.

LO 77.3

Portfolio value is based on the no-default value (NDV), less a credit value adjustment (CVA) representing the potential for counterparty default, plus a debit (or debt) value adjustment (DVA1) representing the potential for bank default on its derivatives obligations. DVA2 (bank defaults on its derivatives funding obligations) and FVA (funding costs on its derivatives) should theoretically offset and, therefore, not be included in valuation.

LO 77.4

FVA represents an entity-specific cost that is potentially incorporated as an offset to portfolio value. Adjustments for funding costs lead to unique valuations that differ from market prices and create the potential for arbitrage opportunities.

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Concept Checkers

1. A credit value adjustment (CVA) is a(n):
   A. addition to portfolio value, representing the potential for the bank to default.
   B. subtraction from portfolio value, representing the potential for the bank to default.
   C. addition to portfolio value, representing the potential for the counterparty to default.
   D. subtraction from portfolio value, representing the potential for the counterparty to default.

2. A funding value adjustment (FVA) will most likely offset which of the following components of the portfolio valuation calculation?
   A. NDV.
   B. CVA.
   C. DVA1.
   D. DVA2.

3. Which of the following statements regarding arbitrage is correct?
   A. Arbitrage is avoidable as long as funding value adjustments are not made.
   B. An arbitrage opportunity may exist if two markets price the same asset at different values.
   C. Valuing a derivatives position based on cost rather than market value limits potential arbitrage.
   D. Arbitrage cannot exist if both FVA and DVA1 are included in the valuation of a derivatives portfolio.

4. The funding value adjustment is the incremental difference in the no-default value when discounting using the risk-free rate versus discounting using the:
   A. LIBOR rate.
   B. dealer's cost of funds.
   C. overnight indexed swap rate.
   D. one-year U.S. Treasury bill rate.

5. Which of the following statements is most accurate regarding the views of traders, accountants, and theoreticians on funding value adjustments?
   A. All three parties typically choose to include funding costs in valuations.
   B. Traders and accountants both prefer to include funding costs in valuations.
   C. Theoreticians and traders disagree on how funding costs should be handled in valuations.
   D. Accountants and theoreticians agree that funding costs should be incorporated into valuations.

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Concept Checker Answers

1. **D** A credit value adjustment (CVA) should be subtracted from the no-default value (NDV) in calculating the value of a portfolio. The CVA is a mathematical representation of the potential that the counterparty defaults on its obligation.

2. **D** FVA represents the average funding costs charged to a derivatives dealer for uncollateralized positions requiring funding. DVA2 represents the value to the bank if it defaults on the funding required for derivatives positions. These two components potentially offset one another (when one is a cost, the other is a benefit) in the calculation of portfolio value.

3. **B** In theory, an asset's price should be based on market (fair) value regardless of entity-specific costs. If this fair value differs across markets, an arbitrage opportunity may exist. To take advantage of this opportunity, an investor can buy in the market with the lower price and sell in the market with the higher price.

4. **B** The FVA represents the incremental difference in the no-default value of a portfolio when discounting using the risk-free rate versus the dealer's cost of funds. The other rates noted (LIBOR, the OIS rate, and the one-year U.S. Treasury bill rate) are often used as proxies for the risk-free rate. Funding value adjustments are used by dealers to compensate for their cost of funding.

5. **C** Theoreticians and traders disagree in that theoreticians believe that funding costs should be irrelevant as it pertains to market valuations, while traders would prefer to incorporate these costs into valuations. Accountants, like theoreticians, believe that prices should be based on fair value (rather than incorporating entity-specific funding costs).

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Self-Test: Risk Management and Investment Management; Current Issues in Financial Markets

10 Questions: 30 Minutes

1. Given the following information, what is the percent of contribution to VaR from Asset A? There are two assets in a portfolio: A and B.

Asset A marginal VaR:	0.05687
Asset A value:	$7,000,000
Asset B marginal VaR:	0.17741
Asset B value:	$4,000,000

A. 64.06%.
B. 24.27%.
C. 35.94%.
D. 63.64%.

2. A portfolio is composed of two securities and has the following characteristics:

Investment in X:	USD 1.8 million
Investment in Y:	USD 3.2 million
Volatility of X:	8%
Volatility of Y:	4%
Correlation between X and Y:	15%

The portfolio diversified VaR at the 95% confidence level is closest to:
A. $14,074.
B. $206,500.
C. $404,740.
D. $340,725.

3. The buy side and sell side of the investment industry have different characteristics when it comes to turnover, investment horizon, leverage, and risk measures used. Which of the following does not characterize the side of the investment industry that would be inclined to use VaR as one of their primary risk measures?
A. Long-term investment horizon.
B. High leverage.
C. Fast turnover.
D. Stop-loss rules are an important form of risk control.

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4. SkyLine Airways has a defined benefit pension scheme with assets of $165 million and liabilities of $150 million. The annual growth of the liabilities is expected to be 4.5% with 2.4% volatility. The annual return on the pension assets has an expected value of 7.8% with 12% volatility. The correlation between asset return and liability growth is 0.35. What is the 95% surplus at risk for SkyLine?
   A. $24.97 million.
   B. $54.81 million.
   C. $18.84 million.
   D. $6.12 million.

5. Portfolio ACC has an expected return of 10%, volatility of 25%, and a beta of 1.2. Assume that the market has an expected return of 8% and volatility of 15%, and that the risk-free rate of return is 4%. What is Jensen's alpha for Portfolio ACC?
   A. 1.2%.
   B. 2.0%.
   C. 3.6%.
   D. 10.8%.

6. Linda Hernandez, FRM, is a hedge fund analyst for a prominent hedge fund allocation firm. Hernandez is concerned about potential measurement errors and various biases in reported hedge fund returns prior to 1996. Looking at hedge fund returns for the largest hedge funds from 1987 to 1996, how would performance be best characterized, and how would various measurement biases affect the performance?
   A. There were so many hedge fund managers not reporting that performance information is deemed unreliable.
   B. Large hedge fund returns were on par with equities, accompanied by a much higher standard deviation.
   C. Selection bias caused large hedge fund returns to have little correlation with the average return of hedge funds in commercial databases.
   D. Large hedge funds substantially outperformed equities, more than enough to account for any measurement biases.

7. John Bennett is examining the potential predatory behaviors of high-frequency trading (HFT) algorithms. He notices that some algorithms work together to push prices down. Which of the following predatory algorithms most likely represents this trading behavior, and why would this algorithm be used?
   A. Quote stuffers; used to slow down competing algorithms and force prices down.
   B. Quote danglers; used to convince another computer to lower its price on apparent (but not real) volume.
   C. Pack hunters; used to profit when stop-loss orders are triggered.
   D. Stop layering; used to create false liquidity and trick competing algorithms into trading at lower prices.

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8. Orange Tree Traders is considering the development of a quantitative trading system (i.e., a black box). Regarding the advantages and disadvantages of algorithmic trading speed, which of the following statements correctly reflects a disadvantage of high-speed trading?
   A. Black boxes sometimes trade with other black boxes.
   B. High-speed trading may narrow spreads if black boxes cause enormous losses.
   C. Firms work against each other to capture a limited number of trading opportunities.
   D. Unfiltered sponsored access decreases liquidity and has the potential to increase trader losses.

9. Proprietary Traders, Inc., plans to use both pre-trade and post-trade risk controls to curtail the risk of high-speed trading. After backtesting a new trading strategy and fully trading that strategy, which of the following risk controls could be implemented post-trade?
   A. Set intraday position limits any time during a trading day.
   B. Place limits on the maximum order size that can be placed.
   C. Implement a kill button in order to prevent new orders from being placed.
   D. Place limits that restrict the number of messages that can be sent to the exchange over a period of time.

10. Derivatives dealers can make funding value adjustments (FVA), which allow for the recovery of average funding costs for any transactions that are uncollateralized. When computing the value of a derivatives portfolio:
   A. FVA represents a benefit and, therefore, an addition to portfolio value.
   B. FVA represents a cost and, therefore, a subtraction from portfolio value.
   C. FVA represents a cost and is, therefore, less than the debt value adjustment (DVA).
   D. FVA represents a benefit and is, therefore, greater than the credit value adjustment (CVA).

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Self-Test Answers: Risk Management and Investment Management; Current Issues in Financial Markets

1. **C** The component VaR factors in both the marginal VaR and the asset value.

   For Asset A: 0.05687 × \$7,000,000 = \$398,090.

   For Asset B: 0.17741 × \$4,000,000 = \$709,640.

   Asset A's percent of contribution to VaR is A's component VaR as a percent of total VaR: \$398,090 / (\$398,090 + \$709,640) = 35.94%.

   Choice A is incorrect because it is the percent of contribution to VaR from Asset B.

   Choice B is incorrect because it is the Marginal VaR weight for Asset A.

   Choice D is incorrect because it is just the asset weight for Asset A.

   (See Topic 62)

2. **D** Step 1: Calculate the volatility of the portfolio.

   $\text{Variance}_{X,Y} = w^2{}_X\sigma^2{}_X + w^2{}_Y\sigma^2{}_Y + 2 \times w_X \times w_Y \times \sigma_X \times \sigma_Y \times \text{Corr}_{X,Y}$

   $\text{Variance}_{X,Y} = 0.36^2 \times 0.08^2 + 0.64^2 \times 0.04^2 + 2 \times 0.36 \times 0.64 \times 0.08 \times 0.04 \times 0.15$

   $\text{Variance}_{X,Y} = 0.00082944 + 0.00065536 + 0.000221184$

   $\text{Variance}_{X,Y} = 0.001705984$

   $\text{Standard deviation} = \sqrt{0.001705984} = 4.13\%$

   Step 2: Calculate the VaR.

   VaR = 1.65 × volatility × portfolio value

   VaR = 1.65 × 0.0413 × \$5m

   VaR = \$340,725

   (See Topic 62)

3. **A** The sell side of the investment industry uses VaR and stress tests as their primary risk measures. The buy side of the investment industry uses asset allocation and tracking error. The sell side has a short-term investment horizon, uses high leverage, and has fast turnover. Risk controls used are position limits, VaR limits, and stop-loss limits.

   (See Topic 63)

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4. **A** Step 1: Calculate the expected surplus growth.

Expected surplus growth = growth in assets – growth in liabilities

Expected surplus growth = (\$165m × 0.078) – (\$150m × 0.045)

Expected surplus growth = \$12.87m – \$6.75m = \$6.12m

Step 2: Calculate the variance then the standard deviation of the A&L.

$Var_{A\&L} = w^2_A\sigma^2_A + w^2_L\sigma^2_L - 2 \times w_A \times w_L \times \sigma_A \times \sigma_L \times Corr_{AL}$

$Var_{A\&L} = 165^2 \times 0.12^2 + 150^2 \times 0.024^2 - 2 \times 165 \times 150 \times 0.12 \times 0.024 \times 0.35$

$Var_{A\&L} = 392.04 + 12.96 - 49.896$

$Var_{A\&L} = 355.104$

Standard deviation = $\sqrt{355.104}$ = 18.84m

Step 3: Calculate VaR of the assets.

VaR = Z-Score × volatility

VaR = 1.65 × \$18.84m

VaR = \$31,086,000

Surplus at risk = expected growth in surplus – VaR

Surplus at risk = \$6.12m – \$31.086m = –\$24.97m

Note: Although it is a negative, it is usually expressed as a positive figure as it is assumed that it is a shortfall.

(See Topic 63)

5. **A** The Jensen measure of a portfolio is computed as follows:

$\alpha = E(R_P) - \{R_F + \beta[E(R_M) - R_F]\}$

$\alpha = 10\% - [4\% + 1.2(8\% - 4\%)]$

$\alpha = 10\% - 8.8\%$

$\alpha = 1.2\%$

(See Topic 65)

6. **D** There were concerns about measurement errors and biases, but the hedge fund outperformance was more than enough to account for any such errors. Large hedge fund returns were highly correlated to the average return of hedge funds in commercial databases.

(See Topic 67)

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7. **C** Pack hunter algorithms join forces to maximize the chance of causing an instrument's price to fall. The pack joins forces to push the price, moving the quote down until it identifies the stop-loss price. Once the stop-loss orders are triggered, there is a sell-off, causing the price to fall. The high-frequency traders then buy the instruments and ride the price back up.

   (See Topic 70)

8. **A** A disadvantage of high-speed trading is that black boxes sometimes trade with other black boxes. Thus, a mistake by one firm can impact the trading strategy of another firm. Advantages of high-speed trading include narrower spreads, increased liquidity, and the ability to quickly capture trading opportunities.

   (See Topic 71)

9. **C** Common pre-trade risk controls include limits on the maximum order size, limits that restrict the number of messages, and intraday position limits. An example of a post-trade risk control is providing a kill button to members. A kill button allows members to cancel all orders and prevent new orders from being placed.

   (See Topic 73)

10. **B** For derivatives transactions that require funding, FVA represents a cost. For a portfolio of transactions that a dealer may have with a single counterparty, the following equation applies:

    portfolio value = no-default value – CVA + DVA – FVA

    (See Topic 77)

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Formulas

Topic 61

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

marginal contribution to value added = (alpha of asset) – [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

Topic 62

diversified VaR: $VaR_p = Z_c \times \sigma_p \times P$

individual VaR: $VaR_i = Z_c \times \sigma_i \times | P_i | = Z_c \times \sigma_i \times |w_i| \times P$

standard deviation of a two-asset portfolio: $\sigma_P = \sqrt{w_1{}^2\sigma_1{}^2 + w_2{}^2\sigma_2{}^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$

VaR of a two-asset portfolio: $VaR_P = Z_c P\sqrt{w_1{}^2\sigma_1{}^2 + w_2{}^2\sigma_2{}^2 + 2\, w_1 w_2 \rho_{1,2}\sigma_1\sigma_2}$

undiversified VaR: $VaR_P = \sqrt{VaR_1{}^2 + VaR_2{}^2 + 2VaR_1 VaR_2} = VaR_1 + VaR_2$

standard deviation of equally weighted portfolio with equal standard deviations and correlations:

$$\sigma_P = \sigma\sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

marginal VaR: $MVaR_i = \frac{VaR}{P} \times \beta_i$

component VaR: $CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$

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Topic 63

surplus = assets – liabilities

Δsurplus = Δassets – Δliabilities

return on the surplus:

$$R_{surplus} = \frac{\Delta Surplus}{Assets} = \frac{\Delta Assets}{Assets} - \left(\frac{\Delta Liabilities}{Liabilities}\right)\left(\frac{Liabilities}{Assets}\right) = R_{asset} - R_{liabilities}\left(\frac{Liabilities}{Assets}\right)$$

Topic 64

liquidity duration: $LD = \frac{Q}{(0.10 \times V)}$

where:
LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

Topic 65

Sharpe ratio: $S_A = \frac{\bar{R}_A - \bar{R}_F}{\sigma_A}$

where:
$\bar{R}_A$ = average account return
$\bar{R}_F$ = average risk-free return
σ_A = standard deviation of account returns

Treynor measure: $T_A = \frac{\bar{R}_A - \bar{R}_F}{\beta_A}$

where:
$\bar{R}_A$ = average account return
$\bar{R}_F$ = average risk-free return
β_A = average beta

Jensen's alpha: $\alpha_A = R_A - E(R_A)$

where:
α_A = alpha
R_A = the return on the account
$E(R_A) = R_F + \beta_A[E(R_M) - R_F]$

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information ratio: $IR_A = \dfrac{\overline{R}_A - \overline{R}_B}{\sigma_{A-B}}$

where:

$\overline{R}_A$ = average account return

$\overline{R}_B$ = average benchmark return

σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

statistical significance of alpha returns: $t = \dfrac{\alpha - 0}{\sigma / \sqrt{N}}$

where:

α = alpha estimate

σ = alpha estimate volatility

N = sample number of observations

standard error of alpha estimate = $\sigma / \sqrt{N}$

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Using the Cumulative Z-Table

Probability Example

Assume that the annual earnings per share (EPS) for a large sample of firms is normally distributed with a mean of \$5.00 and a standard deviation of \$1.50. What is the approximate probability of an observed EPS value falling between \$3.00 and \$7.25?

If EPS = x = \$7.25, then $z = (x - \mu)/\sigma$ = (\$7.25 – \$5.00)/\$1.50 = +1.50

If EPS = x = \$3.00, then $z = (x - \mu)/\sigma$ = (\$3.00 – \$5.00)/\$1.50 = –1.33

For z-value of 1.50: Use the row headed 1.5 and the column headed 0 to find the value 0.9332. This represents the area under the curve to the left of the critical value 1.50.

For z-value of –1.33: Use the row headed 1.3 and the column headed 3 to find the value 0.9082. This represents the area under the curve to the left of the critical value +1.33. The area to the left of –1.33 is 1 – 0.9082 = 0.0918.

The area between these critical values is 0.9332 – 0.0918 = 0.8414, or 84.14%.

Hypothesis Testing – One-Tailed Test Example

A sample of a stock's returns on 36 non-consecutive days results in a mean return of 2.0%. Assume the population standard deviation is 20.0%. Can we say with 95% confidence that the mean return is greater than 0%?

H_0: $\mu \leq 0.0\%$, H_A: $\mu > 0.0\%$. The test statistic = z-statistic = $\frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$ = (2.0 – 0.0) / (20.0 / 6) = 0.60.

The significance level = 1.0 – 0.95 = 0.05, or 5%.

Since this is a one-tailed test with an alpha of 0.05, we need to find the value 0.95 in the cumulative z-table. The closest value is 0.9505, with a corresponding critical z-value of 1.65. Since the test statistic is less than the critical value, we fail to reject H_0.

Hypothesis Testing – Two-Tailed Test Example

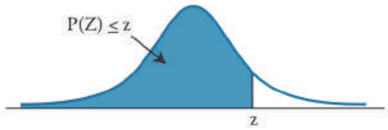
Using the same assumptions as before, suppose that the analyst now wants to determine if he can say with 99% confidence that the stock's return is not equal to 0.0%.

H_0: $\mu = 0.0\%$, H_A: $\mu \neq 0.0\%$. The test statistic (z-value) = (2.0 – 0.0) / (20.0 / 6) = 0.60. The significance level = 1.0 – 0.99 = 0.01, or 1%.

Since this is a two-tailed test with an alpha of 0.01, there is a 0.005 rejection region in both tails. Thus, we need to find the value 0.995 (1.0 – 0.005) in the table. The closest value is 0.9951, which corresponds to a critical z-value of 2.58. Since the test statistic is less than the critical value, we fail to reject H_0 and conclude that the stock's return equals 0.0%.

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Cumulative *Z*-Table

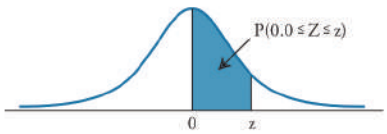


$P(Z \leq z) = N(z)$ for $z \geq 0$
$P(Z \leq -z) = 1 - N(z)$

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.937	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.983	0.9834	0.9838	0.9842	0.9846	0.985	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.994	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

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Alternative Z-Table

$P(Z \leq z) = N(z)$ for $z \geq 0$

$P(Z \leq -z) = 1 - N(z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3356	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4939	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

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Student's T-Distribution

Level of Significance for One-Tailed Test						
df	**0.100**	**0.050**	**0.025**	**0.01**	**0.005**	**0.0005**
Level of Significance for Two-Tailed Test						
df	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.001**
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.294
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

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76. The Changing Landscape for Derivatives

After completing this reading, you should be able to:

1. Discuss the background and current status of OTC trading. (page 179)
2. Discuss how a central counterparty (CCP) can operate as an OTC derivative trading venue with respect to clearing and reporting. (page 180)
3. Explain the concept of too-big-to-fail CCPs, and discuss some points of weakness in this concept. (page 180)

77. Valuing Derivatives: Funding Value Adjustments and Fair Value

After completing this reading, you should be able to:

1. Understand the use and purpose of funding value adjustments (FVA). (page 185)
2. Compare and contrast the view on funding FVA from the perspectives of trading, accounting and financial theory. (page 185)
3. Distinguish between FVA and debit (or debt) value adjustment (DVA) and credit value adjustment (CVA). (page 186)
4. Evaluate the implications of using FVA, including the potential for arbitrage. (page 187)

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Reading Assignments and Learning Objectives

The following material is a review of the Risk Management and Investment Management, and Current Issues in Financial Markets principles designed to address the learning objectives set forth by the Global Association of Risk Professionals.

Reading Assignments

Risk Management and Investment Management

Richard Grinold and Ronald Kahn, *Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk, 2nd Edition* (New York: McGraw-Hill, 2000).

61. "Portfolio Construction," Chapter 14 (page 1)

Philippe Jorion, *Value-at-Risk: The New Benchmark for Managing Financial Risk, 3rd Edition*. (New York: McGraw Hill, 2007).

62. "Portfolio Risk: Analytical Methods," Chapter 7 (page 13)

63. "VaR and Risk Budgeting in Investment Management," Chapter 17 (page 30)

Robert Litterman and the Quantitative Resources Group, *Modern Investment Management: An Equilibrium Approach* (Hoboken, NJ: John Wiley & Sons, 2003).

64. "Risk Monitoring and Performance Measurement," Chapter 17 (page 46)

Zvi Bodie, Alex Kane, and Alan J. Marcus, *Investments, 9th Edition* (New York: McGraw-Hill, 2010).

65. "Portfolio Performance Evaluation," Chapter 24 (page 57)

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing* (New York: Oxford University Press, 2014).

66. "Illiquid Assets," Chapter 13 (page 79)

G. Constantinides, M. Harris and R. Stulz, eds., *Handbook of the Economics of Finance, Volume 2B* (Oxford: Elsevier, 2013).

67. "Hedge Funds," Chapter 17 (page 93)

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Kevin R. Mirabile, *Hedge Fund Investing: A Practical Approach to Understanding Investor Motivation, Manager Profits, and Fund Performance* (Hoboken, NJ: Wiley Finance, 2013).

68. "Performing Due Diligence on Specific Managers and Funds," Chapter 11 (page 105)

Current Issues in Financial Markets

69. Roe, M. (2013) *Clearinghouse Overconfidence. California Law Review*, 101 (6), pp. 1641–1703. (page 119)

70. O'hara, M. (2014). *High-Frequency Trading and Its Impact on Markets*. Financial Analysts Journal, 70, 3. pp. 18-27. (page 129)

71. Clark, C. (2010). *Controlling Risk in a Lightning-Speed Trading Environment*. (page 136)

72. Clark, C. (2011). *How Do Exchanges Control the Risk of High Speed Trading*? (page 143)

73. Clark, C. and Ranjan, R. (2012). *How Do Proprietary Trading Firms Control the Risks of High Speed Trading*? (page 150)

74. "Report on Cyber Security in the Banking Sector," New York State Department of Financial Services. May 2014. (page 160)

75. "Framework for Improving Critical Infrastructure Cybersecurity," National Institute of Standards and Technology. February 2014. (page 169)

76. "The Changing Landscape for Derivatives," by John Hull, Joseph L. Rotman, School of Management University of Toronto. (page 180)

77. Hull, J. and White, A. (2014). *Valuing Derivatives: Funding Value Adjustments and Fair Value*, Financial Analysts Journal 70 (3), pp. 46–56. (page 186)

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Learning Objectives

Risk Management and Investment Management

61. Portfolio Construction

After completing this reading, you should be able to:
1. Distinguish among the inputs to the portfolio construction process. (page 1)
2. Evaluate the methods and motivation for refining alphas in the implementation process. (page 1)
3. Describe neutralization and methods for refining alphas to be neutral. (page 2)
4. Describe the implications of transaction costs on portfolio construction. (page 3)
5. Assess the impact of practical issues in portfolio construction such as determination of risk aversion, incorporation of specific risk aversion, and proper alpha coverage. (page 3)
6. Describe portfolio revisions and rebalancing and evaluate the tradeoffs between alpha, risk, transaction costs and time horizon. (page 5)
7. Determine the optimal no-trade region for rebalancing with transaction costs. (page 5)
8. Evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. (page 6)
9. Describe dispersion, explain its causes and describe methods for controlling forms of dispersion. (page 7)

62. Portfolio Risk: Analytical Methods

After completing this reading, you should be able to:
1. Define, calculate, and distinguish between the following portfolio VaR measures: individual VaR, incremental VaR, marginal VaR, component VaR, undiversified portfolio VaR, and diversified portfolio VaR. (page 13)
2. Explain the role correlation has on portfolio risk. (page 14)
3. Describe the challenges associated with VaR measurement as portfolio size increases. (page 18)
4. Apply the concept of marginal VaR to guide decisions about portfolio VaR. (page 22)
5. Explain the difference between risk management and portfolio management, and describe how to use marginal VaR in portfolio management. (page 23)

63. VaR and Risk Budgeting in Investment Management

After completing this reading, you should be able to:
1. Define risk budgeting. (page 30)
2. Describe the impact of horizon, turnover and leverage on the risk management process in the investment management industry. (page 30)
3. Describe the investment process of large investors such as pension funds. (page 31)
4. Describe the risk management challenges associated with investments in hedge funds. (page 32)
5. Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk and sponsor risk. (page 32)
6. Apply VaR to check compliance, monitor risk budgets and reverse engineer sources of risk. (page 35)

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7. Explain how VaR can be used in the investment process and the development of investment guidelines. (page 37)
8. Describe the risk budgeting process across asset classes and active managers. (page 38)

64. Risk Monitoring and Performance Measurement

After completing this reading, you should be able to:

1. Define, compare and contrast VaR and tracking error as risk measures. (page 46)
2. Describe risk planning, including its objectives, effects and the participants in its development. (page 47)
3. Describe risk budgeting and the role of quantitative methods in risk budgeting. (page 48)
4. Describe risk monitoring and its role in an internal control environment. (page 48)
5. Identify sources of risk consciousness within an organization. (page 48)
6. Describe the objectives and actions of a risk management unit in an investment management firm. (page 49)
7. Describe how risk monitoring can confirm that investment activities are consistent with expectations. (page 50)
8. Explain the importance of liquidity considerations for a portfolio. (page 50)
9. Describe the objectives of performance measurement. (page 51)

65. Portfolio Performance Evaluation

After completing this reading, you should be able to:

1. Differentiate between time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses. (page 57)
2. Describe and distinguish between risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and information ratio. (page 60)
3. Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios, and the graphical representation of these measures. (page 60)
4. Describe the statistical significance of a performance measure using standard error and the t-statistic. (page 67)
5. Explain the difficulties in measuring the performance of hedge funds. (page 68)
6. Explain how changes in portfolio risk levels can affect the use of the Sharpe ratio to measure performance. (page 68)
7. Describe techniques to measure the market timing ability of fund managers with a regression and with a call option model. (page 69)
8. Describe style analysis. (page 71)
9. Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision and the aggregate contribution. (page 71)

66. Illiquid Assets

After completing this reading, you should be able to:

1. Evaluate the characteristics of illiquid markets. (page 79)
2. Examine the relationship between market imperfections and illiquidity. (page 80)
3. Assess the impact of biases on reported returns for illiquid assets. (page 81)
4. Compare illiquidity risk premiums across and within asset categories. (page 83)
5. Evaluate portfolio choice decisions on the inclusion of illiquid assets. (page 87)

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67. Hedge Funds

After completing this reading, you should be able to:

1. Describe the characteristics of hedge funds and the hedge fund industry, and compare hedge funds with mutual funds. (page 93)
2. Explain biases which are commonly found in databases of hedge funds. (page 93)
3. Explain the evolution of the hedge fund industry and describe landmark events which precipitated major changes in the development of the industry. (page 93)
4. Evaluate the role of investors in shaping the hedge fund industry. (page 93)
5. Explain the relationship between risk and alpha in hedge funds. (page 94)
6. Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy. (page 95)
7. Describe the historical portfolio construction and performance trend of hedge funds compared to equity indices. (page 98)
8. Describe market events which resulted in a convergence of risk factors for different hedge fund strategies, and explain the impact of such a convergence on portfolio diversification strategies. (page 99)
9. Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry. (page 99)
10. Explain the impact of institutional investors on the hedge fund industry and assess reasons for the growing concentration of assets under management (AUM) in the industry. (page 100)

68. Performing Due Diligence on Specific Managers and Funds

After completing this reading, you should be able to:

1. Identify reasons for the failures of funds in the past. (page 105)
2. Explain elements of the due diligence process used to assess investment managers. (page 106)
3. Identify themes and questions investors can consider when evaluating a manager. (page 107)
4. Describe criteria that can be evaluated in assessing a fund's risk management process. (page 109)
5. Explain how due diligence can be performed on a fund's operational environment. (page 110)
6. Explain how a fund's business model risk and its fraud risk can be assessed. (page 112)
7. Describe elements that can be included as part of a due diligence questionnaire. (page 113)

Current Issues in Financial Markets

69. Clearinghouse Overconfidence

After completing this reading, you should be able to:

1. Synthesize the advantages of using clearinghouses for trading derivatives. (page 119)
2. Analyze the role of clearinghouses in reducing contagion and systemic risk in financial markets. (page 121)
3. Apply the concept of "too big to fail" to the use of clearinghouses. (page 124)
4. Evaluate the shortcomings of clearinghouses in reducing risk. (page 124)

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70. High-Frequency Trading and Its Impact on Markets

After completing this reading, you should be able to:
1. Distinguish between algorithmic trading and high frequency trading (HFT). (page 129)
2. Identify factors that drove the evolution of HFT. (page 131)
3. Discuss the implications of HFT on regulation in financial markets. (page 131)
4. Distinguish between liquidity and timing risk. (page 132)

71. Controlling Risk in a Lightning-Speed Trading Environment

After completing this reading, you should be able to:
1. Explain the importance of speed to high frequency trading. (page 136)
2. Describe ways in which market participants can speed up their trading. (page 137)
3. List the advantages and disadvantages of speed. (page 138)
4. Describe pre-trade and post-trade risk controls used in the marketplace. (page 139)

72. How Do Exchanges Control the Risks of High Speed Trading?

After completing this reading, you should be able to:
1. Explain the pre-trade risk controls used by exchanges. (page 143)
2. Describe offerings exchanges make to their clients to help manage risk. (page 144)
3. Describe monitoring for and mitigation of abnormal trading and market manipulation. (page 145)

73. How Do Proprietary Trading Firms Control the Risks of High Speed Trading?

After completing this reading, you should be able to:
1. Summarize the lifecycle of a new trading strategy for a trading platform. (page 150)
2. Describe a firm's risk management structure and the role of risk platforms. (page 151)
3. Explain the pre-trade and post-trade risk controls employed by trading firms. (page 152)
4. Describe the key challenges and best practices in firms' risk management. (page 154)

74. Report on Cyber Security in the Banking Sector

After completing this reading, you should be able to:
1. Describe factors contributing to increased cyber crime against financial institutions. (page 160)
2. Discuss present trends in corporate governance as it relates to cyber security, and explain the implications of these trends. (page 161)
3. Assess the greatest challenges financial institutions face in achieving adequate cyber security. (page 163)

75. Framework for Improving Critical Infrastructure Cybersecurity

After completing this reading, you should be able to:
1. Explain the five core functions in the framework that an organization can use to mitigate cyber security risk, and provide examples of activities associated with each function. (page 169)
2. Explain how an organization can implement and communicate a process to manage cyber security risk. (page 171)
3. Describe methodologies an organization can use to address privacy and civil liberties concerns associated with cyber security operations. (page 173)

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